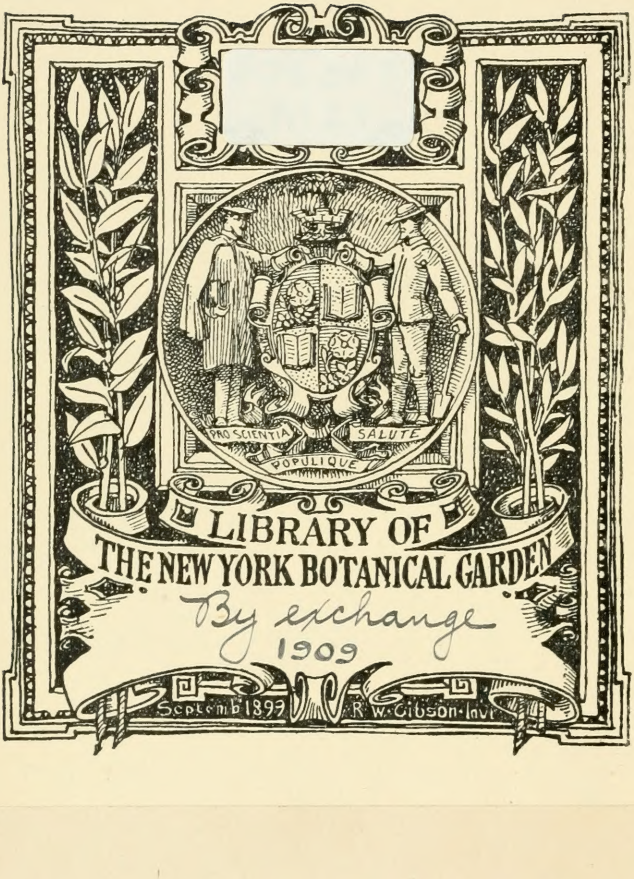
REPORT

OF

FOREST COMMISSIONER

MAINE, 1896



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THIRD ANNUAL REPORT

OF THE

FOREST COMMISSIONER

OF THE

STATE OF MAINE

1896.

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STATE OF MAINE.

To the Honorable Governor of the State of Maine:

The Forest Commissioner respectfully submits his third report as required by the act of 1891, chapter 100, creating a Forest Commission.

CHARLES E. OAK,
Forest Commissioner.

ERRATA.

On page 88, 4th line, for *twenty* read *twenty-four.*

On page 176, 3rd paragraph, 5th line, for *20* read *24.*

On page 34, the fine mountain west of Parlin Pond known as Bald Mountain, is referred to. There are several mountains so named in the region, and the name does not well characterize this one. The owners of the land, therefore, considering these facts and wishing moreover to perpetuate thus the name of a former eminent citizen of the State, have recently renamed the peak Mt. Coburn.

ERRATA IN REPORT OF 1894.

Owing to lack of expert proof-reading a number of bad errors got into the previous report. Following are the worst of them:

The note on page 28 should be cut out.

On page 29, top line, for *twenty* read *twenty-four.*

On page 32, 7th line from bottom, for *fifteen* read *.15.*

On page 34, 3rd paragraph, 2nd line, for *thirteen* read *1.3.*

On page 91, 2nd paragraph, bottom line, for *straight* read *strength.*

On page 91, last paragraph, 3rd line, for *effect* read *offset.*

REPORT.

The work of the department for the past two years has differed but little from that outlined in the report of 1894.

In order that everybody, visitor as well as resident, might be familiar with our forestry laws, "*Fire notices*" giving extracts from the law have been posted beside nearly every lake, stream and woods-road in the State, frequented by sportsmen and tourists, as well as in hotels, railroad depots and other public places. In most instances the wild land proprietors have attended to the work of posting these notices and we have supplemented their work by very numerous letters and personal appeals, urging fire wardens to attend to their duties, guides and woodsmen to be especially careful to guard against fires, and railroad companies to conform with the law requiring them to clear their right of way of brush, grass and other inflammable material at least once a year and also to use the most approved appliances on their locomotives to prevent scattering fires.

The great necessity of extinguishing camp fires and otherwise guarding against forest fires, I hardly think was ever fully appreciated until the attention of the people was called to the fact by means of these fire notices, but as we now find they are generally disposed to observe the law in this respect, after having it called to their attention, we can but believe that the notices have served their purpose and done a great amount of good.

The season of 1895 was exceedingly dry and very numerous small forest fires occurred, but, although every one feared that there might be extensive conflagrations, we fortunately escaped.

For this fortunate exemption the department claims no great merit, realizing that extensive fires were prevented in the main on account of the people having waked up to the necessity of looking after and extinguishing them before they got beyond their control.

I am sorry to be obliged to report, however, that in several instances when poor, disinterested men put in considerable time and hard labor to prevent fires and protect the property of others, they failed to receive any compensation whatever, owing to a defect in our law which fails to provide means by which they can collect their pay in all instances.

To my mind this needs remedying, as otherwise we cannot expect any great assistance from such parties, and they are often in position to render more effective service than any other class of people we have.

Also in case of the railroad companies there should be some change in the law so that more exact information can be obtained and means provided by which they will be compelled to more nearly comply with the law than they do in some instances at present. During the present season, since early summer, there has not been any great risk from fires, owing to frequent showers or rains, yet it has been an exceptional year in that respect.

Usually there are two periods of drought—spring and late summer or fall. In each season forest fires are very liable to do immense damage, and it is suggested that if railroad companies at such seasons were obliged to send section men over their beats immediately after each train for the especial purpose of extinguishing fires set by sparks from the locomotive, it would seem to be a great safeguard, and we need all reasonable safeguards possible.

It seems important also that town and county officers should report to this office a full list of all fire wardens appointed throughout the State and that all such wardens should be under the direction of the commissioner when he so desires.

As the law stands at present, the commissioner is powerless to act in case of emergency—having no men at his command or means to employ them, excepting the fish and game wardens and these are so few and their beats so long, they cannot be depended on unless the fire is in their immediate vicinity. In several instances of that kind the past season, however, they have rendered good service.

It is with some feeling of embarrassment that the work of investigation regarding forest growth and supply is reviewed for the reason that I fully realize that we are venturing on a new field of study with little or no training for the business, or source from which to gather the necessary information to direct our study. In this country it is an almost entirely new field for work and thought, and as in the case of all pioneers the result of our labors must necessarily be somewhat crude and unfinished. Without precedent, guide, chart or compass, it could not well be otherwise.

Still as the results of our efforts as published in the report of 1894 were so favorably received, and more information upon the same lines of work earnestly solicited, we have ventured on the work again and publish a portion of the results that we hope will be equally well received.

We find that the interest in the subject is constantly increasing as evidenced by the demand for forestry literature, not only by those who wish practical information for the management of their own interests, but also by the students of nature searching for all-round information. From nearly every state in the Union have come applications for copies of our laws, reports, literature for distribution and lists of best authorities upon the subject of forestry. It shows, at least, that although there may not be any great apprehension that we may soon be reduced to the condition of some foreign countries in our forest products, yet the necessity of learning methods of economy, of obtaining a knowledge that can be put in practice if required and of mastering the facts necessary to establish intelligent forestry regulation seems to be appreciated. Thus the encouragement received from the favorable criticisms of former work has furnished the incentive to go on.

One serious difficulty we find confronting us in arranging for work at all complete, is the fact that we have no reliable maps of our forest region. In fact all published maps are of the crudest nature, simply showing on a very small scale a checkerboard of township lines with a partially correct plot of the rivers, streams and lakes. Many streams are not shown at all on such maps and those that are laid down are not to be depended on for correctness in locality.

I also realize that we are likely to offer some conclusions and ideas, not fully in harmony with preconceived ideas ot certain individuals, whose long experience in caring for forest lands and handling forest products necessarily gives their opinion great weight.

To all such I wish to say that it is with no desire to antagonize their opinion, or to prove our own that this work was commenced, but simply to deduce the actual facts bearing upon the growth and supply of spruce within our State, with a plain recital of how the facts were obtained, leaving readers themselves in many instances to draw their own conclusions.

In our previous report we discussed spruce growth almost entirely, and have continued our studies with reference to that wood alone for several reasons.—One being that our means have been so very limited it was impossible to cover much ground with a sum of money appropriated annually that would be but little more than sufficient to explore *a single township* in a thorough manner.

Another reason was because spruce is our greatest forest product, the most in demand, and the demand is likely to increase as the pulp mills multiply.

Also because the pulp mills consume in many instances, vast quantities of undersized lumber, which is causing many people to feel somewhat alarmed, fearing as they do, that these mills will prove a great injury to our business interests.

It suggests the necessity at least of having more complete information regarding forest growth, and also the possibility of needing some legislative restrictions before very many years.

To such as feel any alarm, I wish to say that the owners of pulp mills have such large amounts of money invested in their plants, it is a matter of great consequence to them to have a permanent business, and no class of business men can be more interested in having wise, rather than destructive methods adopted, then these proprietors themselves.

Spruce being our main subject of inquiry, let us review the facts, which, partly as a result of earlier work, are already at hand.

The great supply of spruce for all Eastern America, is said to be found in Maine, New Hampshire, New York, West Virginia, Eastern Canada, New Brunswick and Nova Scotia, with possibly small tracts in Vermont and Pennsylvania.

What the total acreage is, the average yield per acre, or the total consumption, it is impossible for the State department to ascertain, yet the necessity of collecting these facts through some source seems of the utmost importance, for without them it will be impossible to ever make any very close calculations with reference to the prospective values of our Maine forests, or those of any other state.

It would seem as though the national department of forestry could well afford to devote a part of its energies towards collecting this most valuable information rather than towards collecting purely scientific data.

The distribution of spruce within our own border can best be indicated by first referring to our great natural features and characteristics.

The great topographical features of this State were clearly apprehended by Walter Wells and admirably stated in his "Water Power of Maine." The whole territory of the State he divided into two slopes, a northern and a southern.

The division between these two slopes is not made by a well defined line or water-shed, but by a great body of elevated land reaching across the State from west to east, a high and uneven country on which the head waters of all our great rivers interlock.

This great plateau whose axis, starting with the White Mountains of New Hampshire, passes across the Rangeley and Moosehead lakes to Mars Hill, carries all the considerable mountains of the State, and is itself elevated through more than half its area to a height of over 1,000 feet above the sea.

Now this plateau may be considered the chosen *habitat* of spruce. Spruce clothes the mountains and mixes with other trees in the cover of ridges and low lands.

From the Kennebec west, the well defined southern boundary of the high lands marks as sharply the distribution of spruce as an important portion of the native timber. On the northeast, in the same way the lower lying and deep-soiled Aroostook county has a far less proportion of spruce, the characteristic timber of the region being the hard woods which there reach their greatest perfection.

Between these two limits, together with the northern slope, is the spruce country of the State, stretching eastward to the New Brunswick boundary, turning south to cover the whole of Washington county and extending thence west along the headlands and islands of the coast.

Turning now to the characteristics and life history of spruce, it was shown in the report of 1894 that the age of the trees which furnish the merchantable spruce logs of the State is something like 200 years, which is too small an estimate for large logs and old growth timbers. The logs involved in this study, numbering over 1,000, were taken at random on the drives and mill yards of the State and averaged only fourteen inches at the butt, with a length of thirty feet and top diameter of nine inches.

Concerning the biological nature of spruce it was shown from a number of considerations that it is hard to suppress and that it requires little from the soil. It covered formerly ne rocky islands along the coast, and it thrives on the steep grades and extremely thin soil of our mountains. Starting readily and rapidly in open ground, it will yet survive dense shading in the forest. The usual reproduction of spruce is according to this latter method. Seedlings start in the shade, grow very slowly through a hundred years or more of suppression, but retain their vitality and take advantage of the first accession of light and air to thicken up their crowns and begin a vigorous growth.

Finding this to be a characteristic of the tree we are assured that, unlike the pine, spruce can never be killed out of our woods, that supplies from the great forest areas of the State will always be in some degree maintained.

With this information regarding spruce to commence with, our next inquiry in order to lay out our work seems to be how much standing spruce have we within the State. It is not necessary for our present work that we should be exact in this matter, yet in the near future, if it becomes certain that spruce growth is becoming exhausted, it will be of the utmost importance to know how much we have, and how much we are diminishing the supply annually if at all.

If decreasing can we by any practical methods increase the supply?

In general our feeling in regard to supply is conservative. We do not anticipate exhaustion of our forest supplies for a long period of years. Yet should it become certain after a few years that the total supply was being exhausted values must necessarily be appreciated considerably, and in that case investments in wild lands will show quite a different rate of increase from that which comes from natural growth.

In arranging the work of investigation I was extremely fortunate in securing the assistance of Mr. Austin Cary of Bangor, a gentleman who is making the subject of forestry a life study, and whose work in collecting the scientific data required by the national department peculiarly fitted him to grasp the practical ideas of which we were in search.

To him in a large measure is credit due should this report prove of merit. In fact without his assistance we should have been able to accomplish but comparatively little, for I know of no other person in the United States with his practical experience. The results of his studies, explorations, investigations and reasonings will be found written in his own language as the principal part of this report.

In arranging the work with him it was decided that it was only in the woods themselves that the specific information which we already had on our list as necessary to obtain, together with many other facts relating to growth, could be obtained. Accordingly it was arranged that he should undertake a trip on the drainage of the Kennebec river, but in our various consultations as to what particular line of work he should follow, we found ourselves confronted with so many different problems, each seeming of some degree of importance and worthy of considerably more time and attention than we could afford to give it, that it seemed impossible to arrange any definite plan of action. Consequently when he started on his long cruise his only specific directions were to avoid for the present, as far as possible, all purely scientific matters, but direct his efforts towards collecting wholesale practical information, facts so necessary for the individual owner in the management of forest lands, as well as bearing on the commercial interests of the State.

I almost said that it was facts desired very much by the individual owner, but that would hardly be true, for I regret to say that the large majority of land owners pay little or no attention whatever to the management of their lands other than to collect all stumpage dues. Unlike all other business, comparatively little study (the word intelligence might almost be allowed) is ever given to the care of wild lands, excepting in a few instances.

Many of our land owners are non-residents and their actual knowledge of their own property, excepting as to what revenues it yields, is very little. Many such owners hardly know one kind of forest growth from another and seem to think, if one can judge by their actions, that the revenues they have yielded in the past will be constant for all time to come. Can it be a matter of wonder then, when the owner himself is so indifferent, that the operator—the person cutting under a permit—is even more so, and that the lumber is cut in a very wasteful and indiscriminate manner?

To bring out a little more prominently the matter of waste, I will quote what I've heard said repeatedly by our best and most practical lumbermen. They state that if to-day we could have what lumber was actually wasted in cutting our old stock of pine for which the State was once so noted, it would be worth more than was received for the stock utilized.

In most cases no restrictions whatever are placed on the operators and they go to the woods, cut what they want, destroy whatever comes in their way in shape of young growing timber with little or no attempt to save a thing that will interfere with their work in the least. In fact operators who work under a permit as far as I have been able to observe their methods, are absolutely indifferent to the interests of the land owner.

Nor is this to be wondered at very much when the facts are considered. The proprietor is mainly interested in securing the largest possible revenues at the smallest possible expense, and charges the operator the largest stumpage rate that he can be made to pay. The operator on the other hand during recent years has been obliged to sell his lumber at a very limited price and consequently has been obliged to cut his lumber in a way and manner that is most likely to yield him a profit on his immediate work regardless of future interests.

The land owners fail to incorporate the needful restrictions in making their permits for the simple reason that neither they nor any one else really know what is necessary in the way of restrictions. The subject never has been studied enough in this country so that anybody can really be called an authority upon it, and the results of foreign investigations are not applicable in this State. There is actually no source from which to derive the information here unless we gather it ourselves. The whole policy thus far seems to have been a "penny wise and pound foolish" one, but we hope the time has arrived when more intelligence will be used.

What then is the practical information we need? What are some of the practical questions necessary to have answered?

The matter of waste is certainly not fully understood and ranks among the first things of importance.

To what extent is it carried on and whether it is practical to introduce other methods of lumbering, not so expensive but that the saving will more than offset the outlay, are facts worth knowing.

No one disputes but that the present methods of cutting are wasteful in the extreme, such, for instance, as felling with an axe instead of a saw and cutting off tops with reference to where the log will scale best: yet if our supply of lumber is good for all time, except to the individual owner, there is no reason for the public, at least, to be at all alarmed at the waste.

How does the matter stand in the State of Maine? Are we increasing or decreasing our stock? If increasing we can rest quietly, while if decreasing at all rapidly, then waste is one of the matters to immediately consider. The situation demands that we know of the consumption of our mills, the standing resources of our timber lands, their condition and growing power. How much of the virgin lands still remain? On lands that have been cut through, how much was left to cut again or to grow?

Some conclusions regarding these questions will be offered after the reader has had a chance to examine the result of Mr. Cary's work.

REPORT OF AUSTIN CARY.

HON. CHARLES E. OAK, *State Forest Commissioner:*

SIR—In accordance with your desire that I should work out in the study of our forest resources a large share of the funds lying at your disposal for such purposes, in the spring of 1895 I returned to the State, and of the work which ensued make the following report:

Purposes and field of this study.

Meeting you by appointment at Augusta, and arranging that the subject of the work should be spruce, it being determined too that the Kennebec, as that one of the larger river basins of the State which had been longest and hardest cut on, was the best field for study, no time was lost in getting into the woods. My outfit was completed at Skowhegan, where also I profited by consultation with Hon. Turner Buswell, manager of the lands of the Coburn estate. From that point I started on June 13th for the spruce woods of the Dead river.

As the job was entered upon, very indefinite ideas were held as to what would come out of it. Your instructions agreed with my own inclination that the objects of the work, whatever its methods, should be of a thoroughly practical nature. Certain minor problems indeed were clearly in mind, and it was hoped, furthermore, that as a result of the study reliable wholesale inferences as to the lumber business of the region could be drawn. But just what shape these would be in, or for how large a territory derived, could not be beforehand determined. That had to be left until through the development and progress of the work itself it should appear what was most worth while and what it was possible to accomplish.

Starting out in this way with partially unformed purposes, and with no precedent, hardly even in the way of method, to guide, first efforts were of necessity largely tentative. Following the leadings of the field work, however, and hardening up ideas gained by means of correspondence with yourself and others interested in the project, the possibilities of the job were at length more clearly apprehended. It appeared after a few weeks that we might make an all-round survey of the spruce resources and prospects of the Kennebec river. From the first, estimates of standing timber had been collected, burnt and waste areas had been mapped and close study made of the condition and growing power of cut-over land. These elements were all unified and given meaning by the purpose named, and it was soon adopted. Travel was therefore directed with this end in view, and detail work so spread as to tell in the solution of the general problem.

A survey of the Kennebec drainage for spruce, with reference not merely to present but to future supply, was, then, the great object of a large portion of the season's work. Later on, the Androscoggin was taken up in much the same way. For the facts required, direct observation was, as far as possible, employed. About three months was spent in travel and field work, between the 13th of June and the 19th of November. Sixty-four days were spent in actual woods exploration, during which I covered by foot travel some 700 miles. Office work—the arrangement and calculation of field notes, prosecution of inquiry by letter, and the literary labor involved in this report—have occupied rather more time than did the field work.

Methods and minor purposes.

To any who fully grasp the problem stated it will be clear that it is a new and difficult one. Experience teaches us that simply collecting estimates of standing timber does not solve it, though that is an important, and by no means easy, part of the work. Growth is already in some regions more than stand the key to future supply, and growth is a subject on which no reliable information is now to be had. Current ideas of it vary very widely, and seldom are they based on record or reliable observation.

Growth, then, not merely in detail but in the gross—the production of the country—is one of the main objects of this study. In that field we are pioneers. The figures upon spruce growth embodied in the last Maine report, worked out from data collected in the employ of the United States Forestry Division were a starting point in this present work. Only a starting point, however. Much more work of the same kind had to be done, and a great body of areal and other facts collected before we could arrive at any general conclusions. Particularly was it necessary to examine at first hands the condition and growing power of a wide extent of cut-over lands. Growth is to be the source of our future supply. What have we left on the land to grow?

The field work which is behind this study was a work of great variety and spread over a wide extent of country. On the Kennebec six townships were somewhat carefully examined, while about half the total number of those that are spruce-bearing were personally visited. The burnt lands were mapped from observation and hearsay; mountains were climbed for the general view; and week after week spent in cruising the country, making detail studies of its growth, and ascertaining in what shape cutting had left it. This field work has been supplemented whenever possible by inquiry. Much indeed has had to be taken in that way,—estimates of merchantable timber rest almost entirely upon information that was so gained. Very much is due to the men who have assisted in this direction. Lumbermen, scalers and others—inquiries have almost always met with appreciation, and the work furthered to the fullest degree.

As to accuracy.

All who have any knowledge of the conditions will of course understand that the results of this study cannot lay claim to exactness. The subject is a great and a new one, while from the nature of the case investigation had to be hasty and methods rough and inexact. Yet this fact does not deprive our work of its value. Approximate information, if it is to the point, will be great gain. General results are what is needed, not fine figuring on any particular problem or piece of land.

The inaccuracies and incompleteness of this work are to no one more apparent than to the writer. That the results in every direction fall far below what could be desired, that the percentage of possible error is great, that questions are asked which cannot be answered, that in the field work corners have been skipped and very much left to judgment or taken at second hand, can be regretted by no one more than by him. These shortcomings, however, there is no desire to conceal. The narrative form is employed in this report because it serves best to bring out the many side issues and break up the information conveyed into comprehensible form. It is welcomed, however, for frankness' sake, that it may be plainly seen how conclusions were arrived at and from how firm a basis of fact. So guarded, our work should carry no undeserved weight, should present no appearance of accuracy that could not be attained.

SPRUCE ON THE KENNEBEC RIVER.

Growth on lower Kennebec.

Provided with a compact outfit of necessary clothes, papers and instruments, I started from Skowhegan on June 13th for Flagstaff on the Dead river. Spruce being the subject of inquiry I was on the watch for it from the start. None was seen, however, for a long distance. Pine was the original coniferous timber of these down-river towns along with some hemlock and cedar and these were mixed and alternated with hard wood. It is the latter element of the original forest that is most prominent to-day, though groves of young pine, lineally descended from the ancient crop, are by no means lacking. Along here the standard hard woods of Maine, beech, maple and yellow birch were noted to be mingled with those belonging to only its warmer and lower portions, oak and bass-wood.

Topography about Lexington.

Stopping over night at New Portland, a town which possesses an interesting industry in the shape of a spool and novelty mill, the stage started north again next morning bound for Dead River via Lexington and Highland. Lexington village is in a big flat, spreading each side from Sandy stream. Mountains lie on the east line of the town and another range, thrown across Highland plantation and down the east side of Jerusalem, separates Sandy stream from the drainage of the Dead river and Carrabasset. Over this last range the road goes in the best pass it can find, climbing on the passage to a height of 1,000 feet above the flat, and descending thence to the level country east of Bigelow on the Dead river.

Southern limit of spruce region.

Here, on the high lands about Lexington, spruce to any amount was for the first time seen. The lower slopes of the mountains to the north and east of Lexington are covered mainly with white birch* grown up thickly after some early fire. The original growth comes down in lobes and patches, however, while to the west the country has never been burnt. A large basin to the northwest was filled with hard woods, among which after cutting but few evergreen tops were showing, while on the heights and steeper slopes the spruce stood nearly pure, running up finally to where it was stunted and unfit for lumber. Five months later, when the circuit of travel was nearly complete, I got another look at this same country. Tramping down the Carrabasset from Eustis and Coplin, I climbed to the highest point in the east part of Jerusalem township, and got from there a bird's-eye view of the whole surrounding country.

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*White birch in the mouth of a Maine man always means Betula papyracea B. populifolia is called gray birch. Yellow birch as commonly used includes B. lutea and B lenta.

Here, let us note, is one point established in the to-be forest map of the State. The high lands in Lexington, Concord and Highland are, in this longitude, the southern boundary of the region in which spruce was and is a prominent feature of the forest growth.

DEAD RIVER.

Passing around the east end of Mt. Bigelow, the road strikes the Dead river not far from Bog brook, the upper end of the old and historic carry; thence it follows the smooth land along the river up to Flagstaff and Eustis. The elevation of this valley is, as near as I can learn, somewhere about 1,200 feet above the sea. Elevated to that extent, and separated from the country south by the mountain barrier mentioned, the region loses some of the forest trees which characterize the southwestern portion of the State. Pine was the timber of the lower and richer lands. Hard woods and spruce clothed the slopes and the mountains.

Settlement and early fires.

Here again the native character of the growth has been disguised by fire. The first settlement on Dead river is said to have been made in 1818. Mr. Caleb Stevens, of Stratton, says that in January of that year his father hauled his wife and nine children through the woods from Kingfield on an ox sled, and the clearing fires of those early settlers were doubtless the cause of the destruction of so much timber. In 1822, according to Mr. Stevens—and in this matter his memory is confirmed by the country and its trees—a great fire started in at Eustis, swept south into northern Coplin, and thence east, burning all the south side of Mt. Bigelow and some of the lower land at its foot. In 1844, again, another fire started in the same locality and ran east down the Dead river, leaving in its wake a burnt strip twenty miles long and of varying but considerable width. Now these old burns are by no means waste land. They bear considerable pine for instance, rapidly growing, and some of it now of merchantable size. Large areas also are well timbered with white birch, which, when near enough to railway, is as valuable as almost any stand of old growth timber. But from the spruce point of view, these lands have to be thrown out of account. Some pulp stuff, and scattering trees of larger size are now to be found, but practically their significance in regard to the spruce supply must for many years be slight.

At Flagstaff one main purpose in going there was fulfilled in meeting John R. Viles. Mr. Viles is an excellent example of a class of men who are very essential to the lumber business of the State, men who combine ability for business management with the capacity for knowing thoroughly a piece of country. Mr. Viles in the course of two or three hours conversation posted me on the character and condition of the towns about; gave me an idea of the lay of the land and recounted in general the history of the cut—all valuable and pertinent information which it would have taken weeks of detailed inquiry to gain. The Dead river was the earliest of the upper waters of the Kennebec to be cut for lumber. This was true of both pine and spruce, and in the recent scouring of the country for pulp wood it has again figured prominently. The main reason for this is the fact that the river, though rough, is comparatively easy to drive. The whole Kennebec is favorably fixed in that respect, and among its tributaries, the Dead river possesses some advantages. The average cost of its drive for the last

Cutting history of Dead river.

sixteen years from the forks of the river in Eustis has been but thirty-five cents per M., while the main river drive to the Riverside boom in Vassalboro costs on the average about as much more. Coöperation having greatly improved the river and reduced booming and storage charges also to the lowest figure, logs are carried to Kennebec mills, and particularly from the Dead river region, at a comparatively small expense.

Recent cutting on the Dead river has been of a very severe kind, and so sweeping in area that but small regions, those far back on the difficult streams, are still uncut. The best of the pine, of course, was years ago cut from every township on the drainage. Spruce began to be cut about 1850, beginning with the best and handiest timber. Of late years the cut has been systematic and severe. The average drive from the Dead river for the last ten years has been forty-eight millions, of which probably eighty per cent has been spruce.* To get this timber Dead river, Flagstaff, III R. IV, Coplin, Lang, East and West Eustis, Jim Pond and Chain of Ponds, have been drawn on heaviest, these towns having been drawn on, according to Mr. Viles, for an average cut of three millions a year. This is more than they have been able to stand, the treatment to which they have been subjected leaving some of them with extremely little of merchantable timber. Other towns vary much in their condition, but the drainage as a whole has been very hard cut, and the tracts which have not yet been cut through for spruce are neither large nor many.

Great recent fires.

Another thing which has damaged the Dead river tremendously as a source of spruce supply is fire. The early fires in Eustis and Coplin, running also twenty miles down the line of the Dead river, have already been mentioned. They must have covered on the Dead river drainage a territory of more than seventy-five square miles. Three also of the most destructive recent fires in the State were on this river. They all occurred according to my information in the year 1886. The largest started in Chain of Ponds town and burnt up 50,000 or 60,000 acres of very irregular shape centering on Jim pond. At the same time another fire burnt across the middle part of Coplin and up through the east part of Lang. The third was further down the Dead river, to the north of it, on both sides of Enchanted stream. Thus nearly or quite 100,000 acres were burnt over on the Dead river in this one year.

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*See appendix for figures bearing on this point.

Eustis, Lang and Coplin have been the scene of frequent smaller fires, while other townships have suffered more or less severely. The effect of these fires on future spruce supply is not more exercised through the timber they burnt up, than through their depressing effect on the growing power of the country.

Timber on Mt. Bigelow.

From Flagstaff village, Mt. Bigelow lies three miles to the south, rising to a height of 3,800 feet above the sea and stretching out about twelve miles of length in an east and west direction. The timber on Bigelow is called better than most mountain spruce, and from what was seen in the day spent on the mountain, that certainly seemed to be the case. The north slope of the mountain was once a great timber country, and in places the original stand still remains. The lower and easier slopes like those of all moun-

HALF ACRE ON MT. BIGELOW, SOMERSET COUNTY, MAINE.

ON SLOPE 25° TO NORTH, EXPOSED, VERY LITTLE SOIL, 2,800 FEET ABOVE SEA.

	SPRUCE.			OTHER SPECIES.			
Diameter—inches.	Number of trees.	Volume—cubic feet.	Height—feet.	Diameter—inches.	Fir.	White birch.	Volume—cubic feet.
*Over 18	3	230	About 70	10-12	1	3	40
* 14-18	14	610	55-70	6-10	35	18	270
†12-14 inclusive	15	360	50-65	3-6	61	18	150
10 and 11	12	120	40-55	Under 3	–	11	10
6-10	18	135					
3-6	23	45		Total	97	50	470
Under 3	–	10					
Total	85	1,510		Many small spruce and fir unscored. Several mountain ash.			

* Five dead in these classes. Few birches over forty feet high.

† Two of these trees worthless. Several of larger ones seamed.

Estimated scale of stand cut for saw logs (8 inches at 24 feet) and scaled as usual here about 3,500 feet.

tains in the region, were covered with a mixed growth of evergreens and hard wood, while the higher and steeper parts are black with their cloak of spruce. In the tramp on the mountain an aneroid barometer was carried, as indeed all through the summer's travel. From notes taken with this on what was seen during the day, the passage from predominant hard wood to predominant spruce may be set at somewhere about 1,000 feet above the river, while the limit of merchantable timber could hardly have been less than 1,000 feet higher. Along from 1,600 to 1,700 at any rate, or nearly 3,000 feet above the sea, the spruce was large, of long body and good quality. Along at that height, trees from twenty to twenty-seven inches in diameter at breast high were not infrequent, while a fair kind of half acre run out tells much about the size and development of the trees, and the relation of different species in the stand. The hard wood at this height, it is particularly worthy of note, is mainly white birth. The relation of this species to spruce in its distribution is a very interesting topic of study, and other reference to it is made in this report.

Cut over land.

This first day's tramp of the season was ended in a noteworthy and somewhat prophetic way by a violent shower which lasted for an hour, and drenched with great impartiality everything out of doors. The blueness of the weather perhaps had more or less to do with the idea gained of those portions of the ground traversed which had been cut over. The lower slopes of the mountain had, as already stated, been cut through for spruce. The work appeared to have been done very cleanly, while wind following had knocked down most of the remaining trees on large areas and left the land in no shape to yield more spruce for a century to come.

NOTE—Cubic foot in this report means exactly that in standard measure, that is, a cube 12 inches on a side or its equivalent in whatever shape. Cubic contents of a tree means the contents of its whole trunk from the ground to the tip, but not the branches. Unless otherwise stated, it includes bark.

Diameter of a tree means in this work diameter breast high, or about 4½ feet from the ground. That is the stsndard of comparison used in the investigations of the United States Forestry Division. It will also be found, I think, for practical purposes a much more satisfactory measure than stump diameter which is now more frequently employed.

Whoever goes north from Flagstaff goes across Flagstaff pond and not around it. The reason for this is that two great bogs border the pond on the east and west. Of these the westerly one, lying along the main inlet, is the larger, reaching nearly or quite to the Eustis line. These two bogs cover, together, an area of several square miles, and make, with the pond, a big hole in the timber-bearing area of the town.

Burn of 1886. Growth upon it.

A tramp of two miles northwest from the pond brought us out into the burn of 1886, lately mentioned. Here there was nothing to interfere with the view—for ten miles in the northerly direction was one unbroken burn. As to the trees growing up on this burnt land, woodsmen need not be told that those most in evidence were white birch and poplar. Clumps of maple sprouts were plentiful, coming up from old stems that had not been entirely killed. The growth of all these species is rapid. Poplars particularly, in the eight years since the fire, had, some of them, reached a height of fifteen feet and a diameter of two inches. This, however, was only on regions possessing a liberal soil.

Much land has no spruce. Blowdown.

A tramp of about eight miles through the burn brought us to Bartlett pond. Securing board in the sportsman's camp located here, two days were spent on the Pratt tract so-called, a tract of 11,500 acres in III R. V, which except for the pine taken from it thirty years or more ago had never yet been cut. But if not cut it has by no means been free from destruction. Striking into it on an easterly course, thinking by systematic travel to see a fair sample of its timber, the first half day's tramp led through an alternation of hard wood growth with blowdown. The timber when it was reached was not even or large. It stood on little rocky knolls or ridges alternating with swampy ground filled with trees of little value and almost every kind. In fact it seemed probable after two days looking around that almost all the spruce and pine timber on this tract stands on not over a third of the land. A big ridge coming in from Hobbstown on the north is almost pure hard wood. Recent fires have clipped its northwest corner and burnt a small piece along the outlet of Spencer pond. Water, swamp and blowdown occupy a large proportion of the remaining area. Yet the Pratt tract is considered one of the best pieces of timber in the region. Anyone who listens to timber talk at Flagstaff or Eustis will be sure to hear a lot about it. Its actual condition is a striking comment on the way in which spruce stands in this portion of the State.

Percentage of growth.

A digression must here be made in order to explain a method of investigation which was first made use of on this tract. The determination of the percentage of growth of trees is a most important matter. A method for that purpose ought to be in use among lumbermen in determining their cutting policy. By its means they could tell what timber is least thrifty, and what, on the other hand, might well be left to grow. In this study, the percentage of growth has a wide use, in fact, it is at the bottom of its most far reaching conclusions. A method of obtaining it on large numbers of trees was essential, a quick and handy method, less expensive and laborious than the cutting down and sectioning of any considerable number.

Pressler's tables.

Such a method was at hand, devised by the German Pressler. He constructed a bit, for the purpose of boring into a tree and taking out a little core of wood. On this the thickness of any desired number of the yearly rings can be measured, and the ratio of this to half the diameter of the tree gives, with tables devised for the purpose, the percentage of present growth. The correctness of the tables of course is the crucial matter. They were calculated from detail measurement of great numbers of trees, the way in which the yearly layer of wood is put on being minutely taken into account. More assuring, perhaps, is the fact that their availability for use on our own trees has been tested in the course of this present investigation. About sixty trees were at one time and another, in the course of the season, chopped down and subjected to careful measurement. The figures have been carefully worked up, and the tables proved, for our trees and conditions, approximately true. A better statement of the case would be to say that the tables are all right, based on exact measurement and calculation; what has been done here is simply to find out how to work with them.

In the course of my season's cruising several men have been met who on hearing of these tables have expressed the greatest interest and been provided with copies at their own request. Anticipating the same interest on the part of others, an extract embodying those figures which have proved best adapted for use on our cut-over spruce lands is here given.

Col. 1—Ratio.	Col. 2—%.
5	5.1
5.5	4.6
6	4.2
6.5	3.9
7	3.6
7.5	3.3
8	3.1
8.5	2.9
9	2.7
9.5	2.6
10	2.5
11	2.2
12	2
13	1.9
14	1.7
15	1.6
16	1.5
17	1.4
18	1.3
19	1.3
20	1.2
22	1.1
24	1.0
26	.9
28	.85
30	.8

For use, these tables must be accompanied by the following rules: Cut into the tree somewhere from four to five feet from the ground, avoiding any bunches or depressions in its surface, and measure the thickness of the outer ten rings. Measure the diameter of the tree at the same height and make a fair deduction for bark. Into the diameter of wood so obtained divide twice the thickness of the rings, and find the number so obtained in column 1. The number opposite in column 2 is the desired rate per cent.

Thus suppose a tree measures thirteen inches in diameter four and one-half feet from the ground, and the outer ten rings at that height measure three-eighths of an inch, or approximately .4 inch, thick. Twice that thickness, or the growth in diameter in the last ten years is .8 inch. Now in a thirteen-inch spruce an inch is a liberal allowance for the bark on both sides, so that the diameter of the tree for this purpose is twelve inches. 12÷.8 is 15, and 15 in column 1 stands opposite 1.6 in column 2. The tree then for the last ten years has been growing at the rate of 1.6 per cent compound interest. As to the accuracy of results obtained by use of these tables it should be said that single trees may depart widely from them. It is designed for use on considerable numbers of trees, thrifty and unthrifty together, the run of what stands on cut-over land. Used in that way, the table ought to give good practical results.

Value and intended use.

This method of obtaining the per cent of growth, and, given the volume of the tree, its actual amount has been used on many hundred trees during the summer's exploration. Being so many in number, and scattered through a large section of our timberlands, arranged too, with relation to the soil, drainage and other biological conditions of the trees involved, the results obtained, checked as was lately described, are thought to be a safe basis for sweeping and important deductions. I propose to use them for no less a purpose than to estimate the growth of spruce upon all the country covered by this study.

Yearly growth on Pratt tract.

Let us now, for the sake of practice, engage in a little percentage calculation on the subject of the Pratt tract. Men who have explored it set its stand of spruce and pine at sixteen million feet, which amount, let us say, stands on 4,000 acres. Now all things considered—the stand and the estimate—it is probable that board feet of merchantable timber cannot, in this case, be converted into cubic feet of wood in the total stand, at a larger ratio than two to one. That makes an average stand—hard wood species left out of account—of 2,000 cubic feet per acre over the 4,000. At one and one-half per cent a year, which probably is quite enough, in a thick and not particularly thrifty stand like this, to allow, the yearly growth is therefore thirty cubic feet. This is the gross amount, in trees of all sizes and qualities. If we could assume that all the trees in this stand will some time reach full size and be harvested, we could convert this figure into board feet at the ratio of four to one, and the yearly gain in lumber would be set at 120 board feet per acre. As a matter of fact, that supposition is not a fair one. In cutting a stand like this, many small trees will be destroyed and not taken, while as it stands much of this growth must be offset by death and decay. The calculation, however, is worth making, for the sake of illustration if not for its own. It shows what the factors in the problem are and how they go together.

Sample areas. Their value.

Finally let me present a sample half-acre from this region, one of a number that were run out and studied. It represents a well-covered piece of ground, thoroughly typical of the bulk of the timber on this tract, and of considerable small and thick spruce timber in other localities. Some things about it seem to indicate that this is a very old second growth which started up after some primeval fire or blowdown. The great number of small trees, many of which are crowded out and either dying or dead, indicates that. So does the mixture of sapling pine and white birch. Such records as these may seem to many of little account, even childish perhaps alongside of the sweeping conclusions which it is sought to establish. This area work, however, served one purpose in training the eye of the observer in the field, while there may be a time and a place where exact records of how the timber in Maine naturally stood will be of interest and value.

HALF ACRE ON III, R. V, SOMERSET COUNTY.

THICK SPRUCE TIMBER OF SLOW GROWTH. LITTLE SOIL BUT ROCKS. COVER OF GROUND MOSS.

SPRUCE.					OTHER SPECIES.				
Diameter—inches.	Number trees.	Height—feet.	Volume—cubic feet.	Diameter—inches.	Pine.	Fir.	Cedar.	White birch.	Volume—cubic feet.
14-17....	6	55-70	230	Over 18 .	1	–	–	–	70
12 and 13	14	55-65	350	14-18 ..	1	–	–	1	120
10 and 11	22	50-65	340	10-14.....	4	–	–	5	190
6-10.........	79	40-55	680	6-10.....	1	–	2	5	70
3-6....... .	31	–	60	3-6. . ..	–	–	5	5	20
Under 3.....	*	–	10	Under 3.	8	*	7	–	30
Total....	152	–	1,670	Total	15	–	14	16	500

* Very many.

Estimated scale if cut to standard of 8 inches at 24 feet, about 2,300 feet.

From a canoe on Spencer pond, a clear idea is obtained of the topography of the two townships in which it lies—

III Range V and Hobbstown. Mountains run up the east line of the towns, rising, some of them, to a height of 1,500 feet above the pond and sending a couple of spurs towards it which divide the intervening territory into great basins. West of the pond, a similar lay of the land is seen. On each side, the hills converge at the head of the pond in very abrupt slopes, while north of that, the country opens out again into the flat and comparatively smooth land of township V, reaching through to Attean pond and the Moose river. This conformation gives to Hobbstown several square miles of waste land for mountain top, in addition to the water, while fires have run into the town on the southwest and north, and cut out considerable areas.

Though some of its timber was practically inaccessible, most of Hobbstown, from the lay of the land, was easy to lumber. The Bradstreets of Gardiner some years ago cut through it, and from what was seen and heard, it was judged that their cut was pretty systematic and thorough. This proved to be the case at any rate in the east portion of the town, about the pass from Spencer pond to the Enchanted country, while travel through its northwest portion disclosed a very bad condition. Two of the peaks northwest of the pond were climbed for the general view, while travel was carried across the basins to see at close range what the country was like. The devastation seen there was remarkable. It points several lessons about timberland which are only to be obtained in the woods.

Blowdown after cutting.

From the first hill climbed it was plain that the country was in very ragged condition. Very few evergreen tops could be seen. Areas of hard wood timber stood scatteringly about, but most of the near country was covered with dense deciduous foliage which seemed to be close to the ground. Striking across for the next mountain, what this appearance meant was plainly seen. A large crop of spruce had been taken from the land. The cut had been followed by blowdown, in most places very thorough, after which there had come up a thick growth of young hard woods. More or less evergreen growth was to be seen, fir with a little spruce mixed in, but the great bulk of it was of hard wood species. So clean was the blowdown that in places half a mile could be travelled without passing an old growth tree. A little area of small standing spruce that we came across was so much of a rarity that we stopped a few minutes, ran a twine string round quarter of an acre and counted up the trees that stood on it. The stand of spruce foots up in all about 1,400 cubic feet per acre, the yearly addition to which might perhaps be twenty-five or thirty. This it is understood is for the place a very exceptional area. If this northwest portion of Hobbstown could be proved to have standing on it 200 cubic feet per acre, or what amounts to much the same thing if it would cut on the average two cords of spruce wood per acre, I should be surprised.

QUARTER ACRE ON HOBBSTOWN CUT TEN YEARS AGO AND PARTLY BLOWN DOWN SINCE. SPRUCE LAND, ROCKY, DEEPLY MOSSED, OF SLOW GROWTH.

Diameter—inches.	Number Trees.						Volume—cubic feet.
	Spruce.	Pine.	Fir.	Cedar.	Birch.	Maple.	
13............	1	–	–	–	–	–	24
9-12.........	11	–	–	–	–	–	150
6-9...........	16	–	–	–	1	–	90
3-6...........	47	–	5	2	2	–	100
Under 3.....	41	8	*	24	48	3	20
Total ...	116	8	*	26	51	3	384

* Very many.

The pleasantest memory I have of Hobbstown is of the spring we found. We had been up among the hills for five or six hours of a hot June day looking, travelling and sketching, had eaten a dry lunch, and finally got pretty uncomfortable for lack of water. Along in the middle of the afternoon we struck north off the mountain, intending to get near the town line, then swing east across the inlet, and so on down to camp at the head of the pond. Scrambling down through the blowdown, up and down through the fallen timber, forcing a passage through the young hard woods that had grown up through it, we were thinking more of coming across some brook than anything else when suddenly to our great delight we ran full tilt upon a spring. A little brook ran from it, but we were at the fountain head—could look way down into the gap in the rocks through which the water issued clear and cold from the sides of the mountain. Such an illustration of the wholesome bounty of nature in this northern country it was well worth half a day's thirst to obtain.

In this connection I am reminded of an incident in the same general line that points a moral too valuable and of too wide application to be left always to the chances of word of mouth narration. It occurred in the spring of 1893, during the progress of the first job I ever undertook for the State, while I was measuring logs and counting rings on the drive of one of our smaller rivers. The lower landings of logs were just being rolled in, and they, with the big wing jams along the river, were the scene of my work. I boarded during my stay with Uncle Billy "Jones," a very fine old gentleman, who besides performing all the ordinary duties of citizenship, serves the State in the unenviable capacity of game warden. It was in April, the river was at flood pitch and running brooks were everywhere. A man could ask nothing better to slake his thirst with than that water just out of the snow banks of the neighboring mountains.

Now Uncle Billy had a well. It stood under the cover of one of his numerous open sheds, where the hens and the pigs had free run. It was just outside the limits of the barn yard. The sink spout discharged in its immediate vicinity, and the various other sources of contamination attending a human habitation stood conveniently near. And the water showed the effects of it. When a little of it was taken into a glass, it appealed to a majority of the five senses. Now Uncle Billy noticed me one day drinking out of the brooks, and he remonstrated with me for so doing. "We don't think much of that brook water," he said. "We don't think its fit to drink; but we've got a well up to the house that gives us the every best of water." I didn't try to convince Uncle Billy that he was at all wrong. I recognized the fact that it was all a matter of individual liking, but I did feel that if Uncle Billy had been pressed with it, he would have had to admit that his was an acquired taste.

Finding at Spencer pond that I had unknowingly got over nearer Moose River settlements than I was to Flagstaff, my Dead River guide, who however had for some days been off his bearings, was discharged, and I started out alone, carrying pack and calipers, over the buckboard road that runs from here to Parlin Pond. Keeping note roughly of direction and distance, constant observation, aided by an occasional side trip either to some high point or up a tree, afforded a pretty good idea of the lay of the land and the extent of the burns. A big area of rough and elevated land lay to the south, while northward the land lay comparatively flat, most of it tributary to the Moose river. The difference in topography was a clue to its timber condition. Townships IV and V have been mostly cut off for the Gardiner mills, while III, rough with mountains and protected by the difficulty of the Enchanted stream which drains it, is, much of it, in its primitive condition. Coming from Hobbstown the contrast was a marked one. Mountain sides covered not with little hard wood sprouts, but dark with spruce tops through which was sprinkled liberally the lighter color of pine, the contrast was most pleasant and relieving. Looking over such land as that one can readily understand how the early explorers could never imagine such a thing as a scarcity of timber.

Virgin timber.

In this locality there seemed to be a good opportunity for two or three days close study. Here was a considerable body of virgin timber likely soon to be brought into the market through engineering skill, while alongside of it, on land of the same general nature, were cuttings of various kind and age. By study of the two in comparison, it was likely that something was to be learned of value for the future.

Species and elevation.

In the first place then as to the land and its original cover. I have already mentioned the high proportion of evergreen trees in the natural stand. In this connection, note in the first place the elevation of the territory. Parlin Pond by surveys for the Somerset Railway is known to be 1,610 feet above the sea. Above that, Bald mountain, on the East line of III and two miles south of the corner, rises, according to independent observations by Judge Buswell and myself, to a height of rather more than 2,200 feet. South of this is the body of elevated land known as Johnson mountain. The whole north half of township III is high, running on the west into the mountain area which centers on the east line of Hobbstown. The country then, for one thing, is elevated, and elevation and exposure in this region tell against hard woods, and in favor of spruce.

Species and soil.

Soil too has much to do with it. The better soils in all this region tend to hard wood or mixed growth. Now in this locality there is little soil of any kind. Ledge rock and boulders are everywhere apparent, and these are covered, not generally by mineral soil, but by moss and mold, one the product of vegetable decay, the other the living plant which grows upon it. This condition of soil, as lumbermen know, is one in which spruce thrives and which it helps to create. This is the black land, or black growth, of our woodsmen, a term derived doubtless from the color of the foliage as seen from the outside. It is contrasted especially with the mixed or hard wood land which through the country as a whole constitutes perhaps a larger area. Not generally characterized by rapid growth, nor possessing trees of the largest size, it is yet the land on which the largest stands of spruce occur per acre. Variations in it seem to be mainly due to drainage. Land that is well broken in surface may be very thrifty. It produces timber of good size and quality, frequently, as in this case, mixed with considerable pine. Land that is flat and therefore poorly drained, is apt on the other hand to produce the thick growths of

Black growth.

small and stunted spruce with which all wanderers in the Maine woods are familiar. All stages of transition are of course to be found.

HALF ACRE ON III, R. SIX, SOMERSET COUNTY.

On Rocky Land, Moss-covered, of Slow Growth.

Diameter—inches.	Pine.		Spruce.		Fir.	
	Number trees.	Volume cubic feet.	Number trees.	Volume—cubic feet.	Number trees.	Volume—cubic feet.
Over 18	8	680	–	–	–	–
14–18...........	4	240	4	140	–	–
13 and 14......	2	75	15	400	–	–
11 and 12... ..	1	25	25	430	–	–
6–10...........	–	–	45	340	–	–
3–6............	–	–	44	90	25	40
Total	15	1,020	133	1,400	25	40

Many very small fir and spruce.
Pines about 90 feet tall. Lumber imperfect.
Tallest spruce about 70 feet.
Numerous dead spruce and pine.

STAND PER ACRE.

Pine, 2,040 cubic feet, about 6,000 feet B. M. saw logs.
Spruce, 2,800 cubic feet, about 6,000 feet B. M. saw logs.

The half acre, notes on which are here presented, was 2,000 feet above sea on nearly level and not specially exposed ground. It is not to be taken as representing the average stand of timber in the country. It has altogether too much pine on it for that. In respect to spruce, too, it represents a large stand, as much in fact as could well grow on the ground in this size of trees. The trunks stood pretty closely together, and their crowns shaded the ground about as densely and evenly as spruce ever does.

In the neighborhood of this area a test was made which illustrates what I said of the value to lumbermen of a means of determining on standing trees the percentage of growth. I wished to test the thriftiness of this particular stand, so selecting large and well crowned trees, running about fourteen inches in diameter, ten of them were

Testing rate of growth.

cut into at breast high, the thickness of the outer six rings measured, and the percentage of growth determined by the use of Pressler's tables. The average of the ten trees was 1.2 per cent, the thickness of the six rings running from one-eighth to one-fourth inch, and averaging a little over two-tenths. Happening soon after to be in a more open growth of mixed hard wood and spruce,—this on a well-drained slope and with something of a soil—the idea struck me that comparative figures would be very interesting. Choosing, therefore, ten representative trees of the same average size as the others, they were treated in the same way. The result is striking. The six rings here average over four-tenths inch in thickness, and the percentage of growth, according to Pressler's formula, is just twice as much as in the other case, or 2.4 per cent. It is possible that this difference is not trustworthy to the fullest extent. Little circumstances and unconscious selection will sometimes affect a result a good deal. But in this case we can deduct considerable for leeway, and still retain a very significant result. Now if a man were planning how to cut a township and found parts of it characterized by as great a difference in thrift as this, it ought not to take him long to decide where it was best to cut first, and what portions should be left for growth.

Cut-over land.

Let us next look over the cuttings in this country and see what may be learned thereby. First as to growth succeeding the cut. The adjacent part of No. IV, the country lying a mile or so north of Horse pond, was cut through for saw logs, as was found by inquiry at Parlin Pond, seventeen years before. Here there was a chance to find out just what the growth on trees left had been, as well as to ascertain what was left on the land to grow by the method of cutting practiced. By this means ideas could be obtained which perhaps might, by proper allowance, be made general. So taking an axeman from Parlin Pond, part of one day was spent in cutting and measuring a few sample trees and the balance of it with the next in looking round, counting trees and measuring and estimating their contents, and also by means of Pressler's method lately described, in determining the rate per cent at which the thinned timber was growing. The cut on this land had been light, not taking trees as a rule that would scale less than about 200 feet. There certainly did seem to be on the land a considerable amount of growing timber.

Mr. Crawford's estimates of growth.

I was particularly anxious at this time to get some definite figures that would compare with estimates of growth on spruce land made by Mr. George T. Crawford of Boston. Mr. Crawford is said to know the wild lands of New Hampshire better than any other man, and great areas have been bought and sold on his judgment. He is also acquainted with the Rangeley region in Maine, and with the timber of the Canadian provinces. A judgment as to growth from such a man, even though it is empirically based, is entitled to a great deal of respect, and I was anxious to check up with him in my own work. His idea is that the growth upon thinned out spruce land is about four per cent on the timber left, and in absolute amount makes an average of perhaps 140 board feet per acre. It was a matter of great interest to find out whether any such figures were going to hold here.

Growth here.

To cut a long story short it may be said at once that on this land the standing trees proved to be growing about 2 per cent on their volume, while after considerable counting, measuring and looking round it appeared that something like 400 or 500 cubic feet of spruce per acre was standing on the ground. In board measure this might amount to say one and one-half thousand feet. Now 2 per cent on 500 is 10, the present yearly growth per acre in cubic feet, which at a fair equivalent might be called 40 board feet. The difference between these and Mr. Crawford's figures is very evident, not to say striking; but it is quite as much apparent as real. The facts have been borne in mind throughout the season's work, and it may be said without further explanation at present that the difference in percents is largely due to a difference in terms and their use which will be explained later on, while in respect to absolute amount much is due to special circumstances and to locality. Later in the season when I got over into the spruce lands of the Androscoggin I found out the conditions from which Mr. Crawford's ideas were derived.

Blowdown after cutting.

One other lesson of importance remains to be drawn. As soon as one got out of the roads in this country he had it very forcibly impressed on his mind that not all the spruce on the ground was standing in a vertical position. However straight one might lay his course by the compass, a multitude of deviations was required to get round the upturned roots, while a vastly greater number in the up and down direction was required to get by the outstretched trunks. There was no doubt but that in the seventeen years since the cut, more than half the timber left standing on the ground had fallen. Making up now an account with the land we shall have to include this important item. The 500 cubic feet now standing seventeen years ago probably was not more than 350. This, however, is not the first charge against the land, but enough more must be added to include the timber blown down. This the growth upon the remainder is not near large enough to balance, so that the whole account shows a loss, not merely of interest but principal.

ACCOUNT WITH LAND DURING SEVENTEEN YEARS SUCCEEDING CUT.

	Cubic feet.	
Left standing at cut	850	
Blown down since	500	
Remainder	350	
Growth on it during 17 years	150	
Now standing	500	
Balance lost		350

Cut some land clean. Why?

Business conditions at the time when this land was cut perhaps did not warrant the cutting of the smaller timber. If so, conditions have now changed. Trees down to a very small size have a market value and are generally cut, and the point of the considerations here presented is that on land like this—nearly pure spruce land, where the trees are not firmly rooted—as a matter of both public and private economy they should be cut. It is a waste to leave timber to blow down, and until lumbering methods are revised from top to bottom, until land and cutting have been studied, and foreman and chopper have been so instructed that timber can be left with reasonable assurance that it will stand up and grow, such land as this had better be cut clean. I heard of the desire of owners of land in this locality to cut with reference to future growth, allowing only trees that would scale 100 feet to be taken. If they are willing to sacrifice something in the way both of immediate profit and of effort, if they will study their land thoroughly and introduce new and economical methods of cutting, training men to carry out their ideas—in a word adopt forestry in place of lumbering—then their purpose is to be highly commended. If, however, they simply mean, as no doubt they do mean, to sell stumpage with the stipulation that only trees scaling 100 feet and over shall be cut, then the results of their policy I am sure will be highly unsatisfactory. They might never know it. Professional land-owners often have no acquaintance with their lands except what may be derived through contemplation of a stumpage account. But the real loss from such a policy will be considerable.

There is nothing exceptional about the facts presented, nothing misleading when the kind of growth is taken into account, and it is also remembered that this is a mountainous country, more subject as a rule to blowdowns than more even land. Most of the blowdown previously seen on Dead river, all of it probably that was seen on virgin land, was due to one great gale, that of November 1883, which covered a larger territory and destroyed more timber than any other gale of which I have been able to hear. The great fires of 1886 also followed in its wake. But what was seen at this point was only the usual and normal thing. Cuttings only three years old showed almost as large a percentage of destruction. On this kind of land the blowing down of thinned out growth is to be expected. The roots of the trees cannot anchor into the ground, but are spread out upon it. The trees of virgin growth mutually shield one another and are braced and interlocked in their crowns. And when after cutting, this support is lost, when each tree stands by itself, open to the full force of the winds, the chances of our ordinary weather can be counted on to upend it. I was myself camped out once in growth of this kind during an October gale. It was on Bald mountain on the Moxie, in the first timber beneath its top. Our fire-place was solid, for it was a faulted ledge four feet high, that served to throw the heat from our fire under the birch-bark shelter that was our protection from the rain. But everything else was afloat. The posts of our habitation were waving round, and the floor, with the whole surrounding surface of vegetable mold knit together with spruce roots, was going up and down with much the motion of an old swell at sea.

Waste in Lumbering.

Before leaving this topic and locality it will be well to bring forward the notes of the sample half acre, suppose an ordinary saw log cut to be made through it, and see what the sequences will be. All the pine of course would be taken out. Of the spruce we will say that all trees are cut which will yield a log scaling eighty feet by the Maine

SAMPLE ACRE (SEE PAGE 35) CUT TO A STANDARD OF 9 IN. AT 24 FT.

NATURAL STAND.			Disposal of same.	Cu. ft.
Diameter inches.	Number trees.	Volume cu. ft.		
12 and over	52	1,360	Logs hauled	1,020
			Stumps and tops—25%	340
3—12	214	1,440	One-third destroyed in cutting	480
			One-half remainder blown down,	480
			Left to grow	480
	266	2,800		2,800

Utilized	1,020 cu. ft	36%
Wasted	1,300 cu. ft	47%
Left to grow	480 cu. ft.	17%

rule, or about nine inches in diameter at twenty-four feet. This will include trees down to about twelve inches four feet from the ground, except crooked and seamy specimens, which however we will not for present purposes take into account. Enough trees to make up nearly half the volume of the stand are taken as merchantable. One-third the remainder is supposed destroyed in cutting, and one-half of what is left is supposed to blow down. The upshot of the matter shows thirty-six per cent actually taken from the ground and utilized, forty-seven per cent wasted in one way or another, and seventeen per cent left on the ground as a basis for growth. This seems to the writer conservative figuring, and the results of it a pointed comment on the wastefulness of present methods of lumbering. The reader must not jump to the conclusion that there is this proportion of waste everywhere. Larger timber and more open growth cut much more economically, while a mixture of hard woods will generally save most of the blowdown. But there are large areas where it is fully believed that a cut for good sized saw logs by present methods will be attended by as great a waste as that here set forth. In closest connection with these figures I wish to put for reflection the following question: Would it work to the promotion of economy in our forests if the State should pass a law as some have suggested prohibiting the cutting of small timber?

Half Acre on III R. VI, Somerset County, on Rocky Land, Moss-Covered of Slow Growth. Thinned by Cutting, but not Blown Down.

Diameter inches.	Spruce.		Fir and Cedar.		
	Number.	Volume cu. ft.	Number.	Volume cu. ft.	
Over 14	6	200			
13 and 14	10	260			
11 and 12	12	220			
6—10	60	400			
3— 6	88	160	2	4	
Under 3	184	20	30	3	Extreme height about sixty feet.
	360	1,260	32	7	

The last observation I will record about this country is the notes of a half acre which had enough trees on it so that it had escaped damage by winds. It is in shape to be compared with the sample half acre on page 35.

Very little had been cut from this ground—three or four pines and a very few of the largest spruce. It was in fact rather an openly covered piece of ground with short trees, than thick growth like the other thinned out. However, it is worth something in the connection.

MOOSE RIVER BASIN.

Kennebec topography

The best way that I know of to acquire, indoors, an idea of the topography of the State is through the study of Wells' "Water Power of Maine" in connection with the best maps. Take for instance the Kennebec drainage. The colored map of the State in the book named shows the area drained by the river, and its relations to other river systems. The text gives the height of certain points upon it; while the maps (of which Hubbard's, and Stuart's timberland plan number six are for the upper country most accurate and available) give the location of some of the watersheds and mountains.

Tributaries Spruce district.

Most of the larger tributaries of the Kennebec run into it from the west. The larger tributaries on that side are in their regular order up stream, the Sandy river, the Carrabasset, the Dead and the Moose rivers. Of these the Dead River drainage is first in size (832 square miles—Wells) and Moose river second (650). The basins of the Sandy River and Carrabasset, while together nearly equal in area to that of the Dead river, are in great part less than 500 feet above sea level, and so smooth and fertile moreover, that they are largely covered by deciduous trees. Only about a third of the territory drained by these two rivers, the higher and rougher lands about their head waters, has to be taken into practical account in connection with the spruce supply. East of the main river only the country from Moscow and Mayfield north has to be so considered.

Moose river topography.

Quite different from the region that was last under consideration is the greater part of the drainage of Moose river. A good place to begin an examination of that region would be Mount Kineo, from which on a clear day with map and compass a general idea of the country can be gained, and considerable learned about its minor features. From that point of view the conception of the Moose river towns as one topographical basin is very distinctly gained. You can see its northern and southern boundaries, and turning west can look for forty miles over the comparatively smooth land that forms the body of it. To the northwest, across northern Middlesex and Revolutionary Soldiers, lies high ridge or mountain land, separating the Moose river from the West Branch Penobscot. This runs finally, on the west, into Moose River Bald mountain. Just across the lake, and south of the mouth of the river, is the Blue Ridge. It is knife-edge shaped, you are looking at it on end, and beyond it in the same range, or a little west of southwest, is the long high ridge called Misery mountain, ending abruptly at Misery pond and prolonged beyond it in the ridge called Cold Stream hill. Maps do not show this relationship—indeed the continuity of the feature is broken at two points, Misery pond as noted and the pass of which the Canadian Pacific has taken advantage,—but the courses of the streams in the region will bear out what is here said. This is the dividing watershed between the lower Moose river and the main Kennebec. Each side of it is a big area of mainly flat and spruce covered land.

A good deal of forestal mapping may be done from Mount Kineo. Just across the lake in southern Tomhegan, stretching across the township to Brassua pond, is a big hard wood country in which as a rule, but little spruce is found. North of that, reaching around across southern Middlesex, and west, is a large area of black growth—that is, land in which evergreens, generally spruce, predominate. Sapling township, Taunton and Raynham, and Sandwich, appear mostly, except for the Blue Ridge, to be of the same general character. Such notes as these, supplemented by inquiry, were all that could be obtained as to many of these towns. They could not all be personally explored. But inquiry, directed toward the original character of the country and its growth, the history of cutting, and whenever it seemed likely to be profitable, the standing timber on the land, discloses much that it is highly desirable to know. It may not only tell us the amount of merchantable timber now standing, but, checked by the careful study of similar areas, permits a judgment to be formed as to the growing power of the land.

Upper Moose River.

Coming to the Moose river via the old Canada road through Parlin Pond one gains a tolerable view of part of the upper Moose river. Large water areas are to be seen. A burn crossed north of Parlin Pond is followed by another in southern Jackman, from which Jackman settlement and a large part of Long Pond, Moose River, Dennis and Attean townships come into view. Here is a great contrast to be noted with Nos. III and IV. The growth here appears to be largely hard wood. The country was in fact originally well spruced, but the large coniferous timber having been cut out, what small stuff there is left makes but a small showing when the cover is viewed from outside. That there was originally a good stand of spruce is learned from several sources. Cuts of 100 millions have been made off some Moose river towns, while the stumps and looks of the growth inside, and the liberal amount of young spruce found nearly everywhere that I travelled, is the best of evidence to the same effect. And there are great advantages in this kind of growth—mixed spruce and hard woods—one of which, comparative freedom of culled growth from damage by winds, will be at once inferred from what has gone before.

Advantages of Moose River.

The Moose river is a rapid-growing country. Underneath it for the most part are slaty rocks, such as produce soil of moderate fertility, and which themselves furnish rooting and nutriment to trees. There is considerable good farming land on the drainage, not all of which by any means is yet utilized. The land lays well too. While seldom rough, it is always uneven, lying generally in swells and ridges which conduce to good drainage. Even the spruce lands as we shall see later are not of the flat, deep-mossed, slow-growing character which spruce lands elsewhere frequently present. They are broken in surface, full of knolls and pinnacles, and therefore well drained. While rocky, they seemed seldom to be entirely destitute of a mineral soil.

The Moose river in fact seems to be from the spruce point of view the best portion of the Kennebec drainage—and this not only in regard to present but future supply. For while distance from market has saved the Moose river to such an extent that according to the estimates obtained, it has now as much standing timber as the Dead river which is a third larger, there are other things about it, relating both to its character and its history, which will operate to its permanent advantage. First of these is its greater average thrift, due to causes just enumerated. Second the smaller proportion of its area which has been burnt. Third—and not likely in the connection to be over-estimated in importance—is its comparative freedom from blowdown due to the mixture of growth, to the presence in most places of a soil in which the trees can firmly root, and to the comparative fewness and distance of mountains whose abundance in a region seems to be a sure sign of frequent destructive winds.

Exploration on Dennistown.

The plan adopted for getting an idea of the upper Moose river towns, was to take a man who was acquainted with the whole region, explore with him one township as near as might be representative of the whole, and then, when he understood what I wanted to learn, and we could talk together from a common experience, and with the assurance of each understanding what the other said, to sit down with him and learn what might be of the stand, cutting history and condition of the whole region. For this purpose, Dennis was the town selected, and Mr. Isaac Newton of Jackman was the man,—a man, by the way, whose knowledge of the country traversed was, from its minuteness and accuracy, a frequent matter of surprise.

So, loaded with provisions for a stay of three or four days, Mr. Newton and I on the first day of July tramped from Jackman up the tote road along Sandy stream, through a burn about twelve years old, to an old camp on the stream about a mile and a half from the north line of the town. The growth along was mixed in its character, the most prominent element from the outside being the hard wood. The town lays nicely for lumbering, being broken up into a number of easy ridges trending generally in a southeasterly direction between the different streams.

How some lumbermen strip land.

Stowing our dunnage away in the camp, and a substantial dinner inside ourselves, we talked about territory to travel. All except the northwest quarter of the township had been cut through at least once. Some of it had several times been cleaned, as was supposed, of merchantable timber. I heard of one piece that had been gone over no less than eight times by different operators, each of them doubtless thinking like his predecessor that he had "got all there was on it." In the district about our camp, Mr. Newton had himself been the last to cut, obtaining the previous winter, spite of many a prediction of failure, 900 M. feet of nice logs on about two and one-half square miles of land. He claimed really to have got it all—neither did he think there was much growing. There was in particular a hard wood ridge country just east of camp where Mr. Newton felt sure that not more than two or three small spruce of any size or description would be found per acre. I took note of this, and glad to tackle any definite problem which as well as another would tell in working out the more general one had in mind, we concluded to go up there.

Mr. Newton and young timber.

No sooner had we got into the territory aimed for than Mr. Newton was ready to acknowledge that his judgment had been badly at fault. It was not that the cutting had been loose, leaving much merchantable timber on the ground. It had on the other hand been systematic and to a low standard *for this part of the country.* Our cross-country travel disclosed only occasional large trees, these being so far from roads that it would not pay to go after them. It was Mr. Newton's eye for small timber that was off. In his lumbering operations he had never bestowed any thought directly upon it, and his recollection and chance impressions proved to be all astray. After looking round a while I got Mr. Newton to pick out a piece of ground that seemed to him not to have more than a fair amount of small spruce on it. This he did, then we ran out half an acre of it and counted up the trees with a result that was more or less of a surprise to both of us.

HALF ACRE ON DENNIS—SOMERSET COUNTY.

MIXED GROWTH CUT FOR SPRUCE WITHIN A YEAR. SOIL COVERED THINLY WITH LEAVES. VERY THRIFTY LAND.

Diameter—inches.	Spruce.		Other Species.					
	Number trees.	Volume—cubic feet.	Diameter—inches.	Fir.	Yellow Birch.	Maple.	Beech.	Volume—cubic feet.
12 and 13.	5	120	Over 18	–	5	3	–	680
10 and 11	2	30	14-18	–	5	4	4	630
8 and 9	8	70	10-14	–	2	7	8	350
6 and 7	7	30	6-10	–	2	8	10	150
3-6	15	30	3-6	16	4	5	5	25
Under 3	47	5	Under 3	53	8	*76	*113	15
	84	285		69	26	103	140	1,850

* Most of these in two old logging roads which crossed the area.

It was easy to see where his cut of between 500 and 600 board feet per acre had come from—just as easy to predict that before many years he could get another crop of the same size. Growth was the key to the matter. Not only was the land extremely thrifty, but the stock of young spruce was such as to keep a crop continually renewing on the land. Such timberland as this, rapid in its growth, well stocked with young trees, of growth so mixed that cutting out of the spruce does not leave it subject to blowdown—is very desirable property to have. No matter how hard it may be cut, the value cannot be entirely taken away from it.

Amount of yearly growth.

And yet the growth upon such land might readily be overestimated, and it is easy, by continued hard cutting, to keep it insignificantly small. The land it was said is extremely thrifty. Determinations by Pressler's tables indicate that a fair percentage of growth for trees between six and twelve inches diameter is three and one-half per cent. But the question turns upon the base. Three and one-half per cent on 500 cubic feet is seventeen and one-half cubic feet of yearly growth per acre, an amount that perhaps may be turned into current measures as seventy board feet of lumber that may some time be utilized. This is, to be sure, a very respectable growth. It means that 1,000 feet of lumber every fifteen years may be taken from the land. But suppose Mr. Newton had been cutting pulp stuff, and that instead of stopping when he did, he had cut all the trees down to ten inches diameter at four feet from the ground. Three hundred cubic feet more are thus removed, the stand of trees six inches and over in diameter is reduced to 200 cubic feet, the yearly growth on which, reckoned in the same way, is only twenty-eight feet B. M.

Effect of pulp-cutting on growth.

A hard cut then reduces the growth upon land for a time to very low figures. If this kind of treatment is maintained—if as soon as trees get up where they are beginning to grow something worth while, they are cut down—this unproductive condition becomes chronic, and the long-run yield of timber from the land insignificantly small. To treat land that way is like raising children only to have them die before they come to do anything on their own account. It is killing the goose that lays the golden egg. It is like fishing a trout stream to death till nobody can catch anything, whereas a policy that is not too greedy to leave a supply of stock fish would maintain a condition from which all could take a reasonable abundance. Small trees, while they grow a big percentage, grow a small amount. If land is to produce well in the long run, it must not be kept forever in a run-down and played-out condition.

Reward of conservative treatment.

So much for that side of the question. Let us now look at the matter the other end to and see how much might be made of this territory. At the rates percent soon to be presented, we can figure the growth of Mr. Newton's half acre for the next twenty years, see what is grown in that time and ascertain the rate per cent which is then characteristic. The results of the computation are given in this little table, side by side with the present stand. The spruce in twenty years time has nearly doubled in volume. An annual growth of 23 cubic feet per acre is seen to have been maintained, which for general purposes we may convert into 92 board feet. At the end of the period the yearly growth is 27 cubic feet or 108 feet in board measure. Thus, by leaving more on the land, or after the accumulation due to lapse of time, the *production* is made to increase. According to the extreme suppositions made, the yearly growth of our sample area therefore varies between 28 and 108 feet. These are figures which both relatively and in their absolute

HALF ACRE ON DENNIS AFTER CUTTING.

STANDING NOW.			TWENTY YEARS HENCE.	
Diameter inches.	Number trees.	Volume cu. ft.	Diameter inches.	Volume cu. ft.
12 and 13	5	120	14.5 and 15	193
10 and 11	2	30	13 and 14	54
8 and 9	8	70	10.5—12	145
6 and 7	7	30	7.5— 9.5	60
			6 and 7	28
		250		480

amount are worthy of the attention of all who have anything to do with timberland.*

With these facts in view take next the notes of a sample half acre in the northwest part of this town where the timber never had been cut. The stand upon it is not like that from which our sample area of thinned-out growth was selected. It is rather a piece of spruce land, without even the proportion of hard wood which is there common. But it will illustrate as well as another the principle which has been brought out. Should this area be cut down to a standard of six inches at twenty feet, with the destruction wrought it would hardly be left in shape to produce twenty board feet per acre. On the other hand, should careful cutting methods be employed and only those trees taken which are over fourteen inches in diameter, the timber that is left seems entirely sufficient to an annual production of 100 feet. And yet the most and the best would have been taken,—somewhat more than half the total stand of spruce in cubic feet, two-thirds or more in value and scale.

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*This contrast might, with justice, be further heightened for the man who is selling stumpage by the Maine rule. A stick 6 inches at 20 feet scales only 25 feet B. M., while a tree yielding such a log has about 10 cubic feet actual wood contents. That is, the seller gets a scale of only 2½ feet for each cubic foot in his tree. On the other hand a tree 16 inches in diameter 4 feet from the ground and 70 feet high has, on the average, about 46 cubic feet in it. From a tree of those dimensions on which I happen to have full notes, a log was cut by the lumbermen 32 feet long, with a top diameter inside bark of 10½ inches. This log constitutes 69% of the total volume of the tree, and scaled as 2 16 foot logs, giving the butt one an inch rise, gives 169 feet B. M. This is 3.7 board feet for each cubic foot in the whole tree, which shows that the man who lets his timber grow to a fit size, not only by so doing gets an increased growth on his land, but he gets a better scale on his trees when he does cut them. That, however, is pretty generally understood.

The ratios between board feet and cubic feet here stated, seem to require a justification of the ratio generally used in this discussion for converting cubic feet of growth into board feet, the ratio namely of 4 to 1. That ratio is based in the first place on the assumption that the increment on all trees of a stand will some time be utilized; secondly, that trees are not cut till they are larger than about 12 inches in diameter 4 feet from the ground; thirdly, that they are utilized up to 6 inches in diameter, and the log scaled in 16 foot lengths with not over 10% discount. These are assumptions that do not hold now. To meet the average of present practice a better ratio probably would be 3 to 1. Some uniform rule was necessary and it seemed better to use one which represents the most careful practice and is therefore more likely to hold in the future.

A word further about the scale of the tree above mentioned will be of value. If cut off at 40 feet, it would, as known from caliper measures taken every 4 feet, have given a log 9 inches in diameter at the top. Ordinary practice again scales this as 2 20-foot logs, giving the butt one 2 inches rise. So cut and scaled, the tree yields 168 board feet, one less than before. And yet the second log contains 16 per cent more wood than the first. This example, which, as practical men know, is thoroughly typical, shows clearly one of the beauties of current methods of measuring lumber—shows how use of the Maine scale rule, or any scale rule which measures diameter at the top end, puts a premium on lumber waste. This matter is commended to consideration. It is more fully dealt with on later pages of this report.

HALF ACRE ON DENNIS—SOMERSET COUNTY.

SPRUCE LAND, UNEVEN, WITH MOSSY COVER, OF RAPID GROWTH.

SPRUCE.			OTHER SPECIES.				
Diameter—inches.	Number trees.	Volume—cubic feet.	Diameter—inches.	Fir.	Yellow Birch.	Maple.	Volume—cubic feet.
Over 18	4	270	6-10.....	12	4	3	130
14-18	15	740	3-6...........	48	12	–	120
12-14 inclusive	17	410	Under 3.. ..	32	27	18	10
10 and 11	10	180		92	43	21	260
8 and 9.......	14	110					
6 and 7......	10	35					
3-6	34	70					
Under 3.......	80	10					
	184	1,825					

Tallest spruce, 75-80 feet.
Average of larger trees, 60-70.

Contrasted policies.

There is an evident contrast between what is here said and the policy that was recommended in regard to Nos. III and IV. Contrast is sometimes exaggerated for the purpose of bringing out distinctly the principles involved. In the present case, however, no exaggeration has been intentionally used. The conditions in the two localities are entirely different and they dictate different policies of management as most desirable for the land. Growth in the one case is twice as rapid as in the other. In the one case small timber may be left with confidence—in the other it blows down. One piece of land then, as a matter of practical policy under current lumbering methods had better be cut clean, though no more spruce need be looked for under seventy-five years. The other will do best if kept stocked with young trees up to twelve or fifteen inches in diameter from which the largest may at periods of say twenty years be cut. The greater natural stand of spruce was on one piece. The possibility of steady and considerable production is with the other.

Usual method of estimating

Before the results lately arrived at regarding growth can be made general, I must digress long enough to explain a method of estimating the amount of small timber which had all along up to this time been the subject of consideration and experiment. Most lumbermen's estimates I find are made not by aid of careful determinations, but by a spot judgment. Much timberland exploring is done by topographical districts. A man wants to know what amount of timber can be hauled into a given stream, so he sets to cruising the territory tributary to it and after having been hrough it sets down without reference to acreage or averaget stand a lump sum for the amount of timber standing and available. This looks like, and is, a very primitive method. It has given rise to tremendous errors, and those without experience can do nothing by means of it. Men of good judgment, however, who have seen much spruce cut, and on land with the nature of which they are familiar, can reach generally pretty accurate results.

Some explorers again look for more things and make their estimates in a more careful and systematic way. Some use a system of counting to assist them, standing in one spot and counting the timber trees to a distance of about seven rods in every direction. Only a few of the more careful men I have met, however, use any such method, and few of them I think really depend on it. Fewer still study the soil or other conditions of growth, or pay attention to the hard wood or to young timber. On the last point, Mr. Newton's ideas were for accuracy probably quite up to the average.

Measurement by counting steps.

For the present purpose some method of getting approximately at the amount of young timber was essential, and it was made the subject of much consideration and trial. Instead of the circle the square seemed to be the best form of surface. The advantage is that one side of this can be paced, and the distance so measured used as a check in estimating the perpendicular sides. This measurement by pacing is so satisfactory for many purposes, and yet in our country is so little used, that it may not be amiss if we devote a little space to it. In a rough country, and through undergrowth and brush heaps, it may be thought that such a method would not work. Such is not the case however. Some allowances of course have to be made, but those learned by practice on measured distances and in different kinds of country, a man travelling on his natural gait, who counts his steps directly or by use of a pedometer, can learn to keep close run of his distances. One caution is essential however. A man ought always to travel with the same purpose. If one day he travels simply to get over the ground, and another slowly, looking about much to examine the country, his results will not be likely, unless allowance is made, to check up.

In the exploration of the past summer, a brief experience in surveying timberland was very helpful. In retracing lines, I used to keep run of my distances in this way, noting when a station was passed how the count tallied with the chaining. Twenty-four hundred steps to the mile used to come pretty close to it, an extra allowance being made on very rough land or in thick undergrowth. At that rate it takes ninety-five steps to the side of an acre.

Estimating small timber.

But an acre is too big a piece of ground to look over thoroughly—at any rate from one side, and when the leaves are on. One would get fooled on distance and on the size of trees. The count of small trees too, would be uncertain. Half the distance is much more manageable, and a quarter acre an area on which neither for size nor stand can a man's eye be much deceived. So the plan was adopted of traveling in straight lines across a country, counting trees to one side to a distance of about forty-eight steps, estimating at the same time their cubic contents and noting at the end of the same distance the results obtained. In this way, long lines of travel and count were run through the towns explored, in some cases systematically and for such long distances that pretty accurate knowledge of the townships so traversed is considered to have been gained. More often the work has not been so thoroughgoing. There was too much ground to cover. A township would be crossed once or twice to get a general idea of its character and condition, or the effects of different kinds of cutting and in different kinds of growth would be examined. In the systematic explorations, too, such counts were not generally continuous. After I had trained myself for a while and began to feel some confidence, the plan was adopted generally of counting for half a mile or a mile in a given growth, averaging up the results, and then depending on the eye so assisted for a further stretch of country. This allowed more ground to be covered, and had the advantage at the same time of affording opportunity to examine the land from other points of view—in respect to other kinds of trees, to undergrowth etc. Count of steps and of trees, with frequently those of log size seperated, with an estimate of the contents of the trees in cubic feet, was quite enough while it was in progress to occupy the mind.

Estimated yearly growth on Dennis-town.

The results of this work on Dennis were not so satisfactory as they were later, after further practice. The results so gained have to be supplemented by general notes and comparisons. Dennis certainly is a region where the production of spruce seems in a fair way to be maintained. Almost everywhere I travelled a good deal of small spruce was to be seen. This was so throughout the mixed growth which covers the body of the town and of which in the three days travel considerable areas were seen. Only one area of pure hard wood land was crossed. Then in different parts of the town there are a number of patches of ground amounting in the aggregate to several square miles in which spruce predominates. Part of this was still uncut, part had been culled for spruce one or more times. On cut-over lands of this nature more spruce on the average was standing than in the mixed growth. Almost all of it was broken in surface and very thrifty. Consideration of all the facts and figures gathered, however, would tend to set the average amount of spruce somewhat below that standing on our sample area. Probably thirty trees per acre over six inches in diameter, and a total stand of 300 to 400 cubic feet will be a safe average for the cut-over portions of the town. That at the best allows only a very few hundred of merchantable saw timber per acre.

Now out of the total area of the town there are some deductions to be made. A twelve-year-old burn in the east half of it cuts out two and one-half square miles from the total area. Water and bog it is thought occupy as much more, while unproductive swamps and hard wood areas cover a little. Perhaps 19,000 acres may be considered as bearing on the average as much spruce as stated. Bringing these facts together, using again the percentage of growth found to be characteristic, and converting cubic into board feet at the ratio of four to one, we get as the yearly growth of spruce lumber on this township from three-quarters of a million to a million feet. To be sure it is not all grown in merchantable form. Some of it is put onto trees which will require many years of further growth before they will be fit to cut for saw logs. But sometime they will reach that condition. The yearly growth on all its trees is the only safe basis for reckoning the production of land.

Growth on mixed spruce and hard wood land.

It will be well at this point to introduce some general figures relating to growth. On page 27 of this report Pressler's method of determining the percentage of growth on standing trees was described. At convenient times during my cruising trees were cut into for the purpose of making this determination. Diameter and height of trees were noted, factors which give approximately the volume, and the general conditions of the trees as well. The table herewith presented gives the results for country such as is the most of Dennis, good land, covered with mixed timber, with all conditions favorable to rapid growth. Behind this table are determinations on about 120 trees, about one-third from Dennis, the rest from similar land at other points. In the field whenever notes of this kind were

GROWTH ON SPRUCE IN CUT-OVER LAND. MIXED TIMBER. BEST CONDITIONS.

Diameter inches.	Estimated volume cu. ft.	GROWTH DURING LAST TEN YEARS.		GROWTH PER YEAR.
		In diameter 4 feet from ground (in.)	In % at compound interest.	In volume cu. ft.
8	7.5	1.2	4.2	.315
9	10.5	1.35	4.1	.43
10	14	1.4	3.9	.55
11	18	1.42	3.55	.64
12	22	1.42	3.2	.70
13	26.5	1.35	2.8	.74
14	31	1.31	2.5	.78

Principles of same. Inferences.

taken, trees between seven and fourteen inches diameter were cut into as they were come to without selection, the only precaution taken being to get no unrepresentative trees—none, that is, that were very badly suppressed and none that had a very unusual crown development. In arranging results, however, the trees have been grouped according to their diameters, and examination of the table will show why. Compare the last two columns for instance. Note the steady decrease of percentage as you go up the scale of sizes. Note the opposite tendency of the growth in actual volume. Note by study of the last column that trees have just begun to lay on wood profitably at ten or eleven inches in diameter, and see how much is lost if they are not allowed to stand longer, but are cut at that time. Mark also the column which shows the rate of diameter growth. This is most rapid at ten and eleven inches diameter, amounting then to an inch in six and one-half years. Above that it shrinks gradually to an inch in eight and one-half years. The growth in volume, however, still increases. It is only that a somewhat larger volume of wood spread over a much larger area makes a thinner layer. This table, alone and in comparison with others of the same nature, given later on, will bear close and repeated examination.

Exploration on Brassua, condition of township.

The next township to be looked over—and it was more thoroughly covered than any previous—was Brassua. This town was pitched on because it was considered to have been very thoroughly cut. Mr. Edward Cullens of Greenville has cut half the township for its owners. He was met at Greenville, and opportunity taken to learn about the territory. About 1,000 acres on the town owned by an heirship has not been cut on for twenty-five years and now has considerable timber. The remainder has been cut over, mostly within the last ten years. Only saw timber has been hauled, but Mr. Cullens said his standard had been six inches at twenty feet. He said, too, that he had done the work thoroughly. The bunches of timber that he knew of on his part of the town were few in number and none of them of any great amount. It was therefore an interesting study to find out just what shape this town was in. What was it in the way of producing? This township is in the shape that its neighbors will soon be in. What is the future of such land to be?

During the five days spent on Brassua I was the guest of Mr. Cullens in his haying crew. On August tenth, I struck out from the camp on Brassua stream for my first day's exploration. Going up stream far enough to get off the timbered lots I mounted the ledge of slate rock that bounds the stream valley, and struck south by the compass through the old works. It was a very ragged country that I got into. There had been a heavy stand of timber on the ground (Brassua is a town that in its day has yielded a hundred millions) and the cut consequently had made a vast change in the looks of the land. Big gaps had almost no trees standing except the small stuff grown up since the cut. Of what was standing, crooked and deformed hard woods, or, in regions where the spruce timber had been thinner, a respectable hard wood growth, was the most to be seen.

Spruce of course was not absent—indeed, I think if what is actually there could be piled up before Mr. Cullens or any

How much does cutting leave?

other lumberman its amount would be a matter of great surprise. I do not here refer altogether to pulp stuff, small trees which in a cut for saw logs it would be impossible to take. I mean trees large enough to make saw timber, which for one reason or another not related to their size and quality are passed by in the cut. How many there are one only discovers when he guides his cruising by the sun or the compass and disregards roads. Near his main roads every lumberman cuts cleanly.* Off on the knolls and ridges at the end of his twitch roads, on the often difficult land where works from different directions meet, bunches of timber will generally be found. It takes nice planning of logging works, and exceedingly close watch of crews besides, to pick up all that might be picked up on the land. Men cutting on stumpage never do it, and most men cutting their own land think it does not pay. So with Mr. Cullens' works. His cut was what he said it was, close and systematic—probably few townships on the upper Kennebec have been cut as closely — yet occasional bunches of timber were found throughout it, running from a few trees up to several thousand feet, always at the heads of the roads and frequently on some pinnacle or piece of broken ground. In addition to this enough trees were scattered along through all parts of the works to make up an average stand of several hundred feet of a good quality of logs, such as any operator would be glad to have.

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* Even this statement must be modified. Half the operators on all our rivers don't know what it is to really clean a piece of ground of merchantable timber. Most, of course, is left where men go to the stump with sleds. I have been in new works of this kind, where on not difficult land 2 or 3 M feet of lumber stood per acre in the shape of logs of all sizes, and yet the operator thought he had cut it clean. Every man says he cuts clean. You have got to know your man to tell what he really means.

A transcript of my count and estimate for a specimen half mile may not be without interest in this connection. Straight across country the course was taken, through brush heaps or whatever else might be in the way. As the ground was covered close watch was kept to one side for an estimated width of 105 feet, and at the end of the same distance, or in fair travelling of forty-eight steps, the results were noted in the shape of the number of spruce trees over six inches in diameter, their estimated contents in cubic feet, and the number of trees of such a size that any lumberman would call them saw logs. Of the latter, doubtless some were hollow or unsound trees which were intentionally left. A fair allowance for this, however, leaves us still a very considerable amount of saw timber on the ground. Looking carefully over the notes of my four days' travel, during which about seven miles of this careful count in different parts of the township was made, I am compelled to believe that not less than 5,000,000 to 10,000,000 feet of first-class logs are so left standing. They would not figure in an ordinary estimate of the country. They may be worth but little in their detached position. But they are there, and they have significance at any rate in connection with the future of the land.

CUT LAND ON BRASSUA. SPRUCE STANDING PER QUARTER ACRE.

	Number trees over six inches diameter.	Number saw logs.	Estimated volume cubit feet.
	10	–	120
	6	3	100
	3	–	30
	3	2	70
	10	1	80
	10	2	100
	8	4	130
	7	2	80
	5	–	50
	7	–	70
	10	1	100
	2	1	30
	13	2	160
	8	3	125
	5	–	50
	13	2	160
	3	–	20
	6	3	80
	3	–	35
	9	–	90
	11	–	80
	22	–	150
	18	–	150
	16	–	130
To'l	208	26	2190
Per acre	35-	+ 4	365

The counts given above also indicate the amount of young spruce on the ground. The average of the half mile given is not greatly different from that of the whole seven miles of count—does not differ from it as much as it is likely to vary from the actual fact. About thirty-three spruce trees per acre over six inches in diameter is the average of the whole, these trees containing about 400 cubic feet. For the small spruce, under six inches in diameter, an addition of perhaps fifty more cubic feet should be made. Not much suffering from wind was noted on the town, though the remaining trees on much of it were very much exposed.

Wind in this region.

Soil and thrift.

There was a gale in 1882 all along the west side of Moosehead lake which broke off the pines and firs, and upset the spruces; but otherwise than that, damage has been small. Spruce and pine in the original stand formed so large a proportion that the township as a whole might be called black growth. Yet it is not such black growth as is some other land that has been referred to. It has not the deep moss cover of some territories, and there is generally some little soil. Except two or three small areas of swamp the township is well broken in surface, and good drainage being thus furnished, the growth as a rule is thrifty. On about 120 trees the percentage of yearly growth was ascertained, and the land thus found to rank with what I have called spruce land of first quality.

BRASSUA—AREA, STAND AND GROWTH.

		Sq. mi.
Gross area		36
Waste land—burnt	1	
water	2	
swamp	1	4
Net area for timber		32

	Sq. mi.	Acres.	SPRUCE—CUBIC FEET.	
			Per acre.	Total.
Timbered lots	2−	1,080	2,000	2,160,000
Hardwood land—cut	5+	3,400	200	680,000
Spruce land—cut	25	16,000	450	7,200,000
Total	32	20,480		10,040,000

	Cu. ft.
Stand on 30 sq. mi. cut over	7,880,000
Yearly growth on same at 3%	236,400
Yearly growth in board feet	945,600

Yearly growth Probable future.

Putting together all facts learned about the territory, the results of exploration, as well as inquiry from Mr. Cullens, the account with the township may be reckoned up about as here given. No reckoning with hard woods is attempted. Of spruce the yearly growth on the thirty square miles cut over is figured at 946 M. feet. This, it is to be noted, is immediately after cutting. Time, as it adds to the volume of the trees now standing, will add also, as a rule, to their growing power. As regards future cutting, definite prediction is risky because it involves not only biological, but business conditions, which it is much harder to foresee. But it certainly seems that this land, with the basis for growth that has been left on it, will be in shape within twenty-five years at the outside so that it will be again gone over for spruce. Probably methods will then be much different. Small crews for one thing will doubtless be the rule. Let us hope also that less wasteful methods of lumbering, those at least which cost no more if men are only trained to use them, will then be in vogue.

Lower Moose river in general.

Now the lower Moose river as near as I can learn is mostly of the same general nature as Brassua. That is, evergreen trees predominate in the cover, while the surface of the ground is uneven, provided with some soil and favorable to tree growth. It is naturally a fine timber country and to say nothing of the hard and soft wood lumber still on it, may be expected to produce always a considerable yield, which yield by intelligent treatment of the country could be greatly increased. Something was seen of Tomhegan in the Brassua trip. The southern portion of the town is mainly a hard wood ridge with a varying amount of spruce which has, where thickest, been cut out. Two-thirds of the town, however, is said to be black growth. This part of the township was crossed, and the land seen appeared to be well stocked with small spruce and fairly thrifty. The township has been cut on longer than Brassua. Thirty years ago the operators of that day reported it cleaned of practicable timber, but notwithstanding that Mr. Oliver Mansell of Greenville has operated on it each winter for the last twenty-seven years, cutting all the way from two to five million. Long ago the town was cut through. Mr. Mansell never knows beforehand just where his winter's work is coming from, but he builds his camp, starts in his crew, and always so far has come out all right. The fact seems to be that Tomhegan is one of those towns that won't stay put. The small timber never was taken off it, and it grows rapidly. Probably the town with its forty square miles of area, nearly all of which is productive land, is growing towards two millions of spruce every year.

The condition and prospects of Tomhegan are quite a contrast with Sapling township, that part of it at least which lies between Churchill stream and Indian pond. Later in the summer that district was crossed a couple of times in passing between Misery farm and Squaw mountain. The land had been cut very hard, but over and above that it was flat and slow growing, with large swamp areas and much worthless growth. The black land of Sandwich and Misery is of a much better type. Thorndike is probably intermediate in the character of its growth between Brassua and Dennis, at any rate very thrifty land. Middlesex and W, except the mountainous portions in the north, link themselves with Tomhegan. These townships, of course, vary much in the amount of merchantable timber standing. The comparisons made relate to the natural character of the timber, and the growing power of the land.

Upper Moose River.

So much for the lower Moose river. The upper portion of the drainage I have had to take more at second hand. The hard wood on these towns must, before very many years, be a valuable resource, and there is hard wood of quantity and quality there. But as producers of spruce also these townships are of value. Spruce formed a considerable proportion of the original stand in all parts of the drainage, and all who were inquired of testified that there is a good deal of small spruce scattered over these lands to-day. Probably in this respect, as also in topography and thrift, Dennis is somewhere near what it was chosen for—a representative town. Its yearly growth of spruce, however, we have set at not much below a million feet.

Yearly production of Moose River.

It will give us easily remembered figures and probably fairly sum up the results of our study of Moose river lands if we should say that after an ordinarily hard cut for saw logs they are left in shape to grow fifty board feet per acre or one million feet to every thirty square miles of productive land. Now the total area drained by the river figures up from the map 650 square miles. Water areas and bog as near as I am able to ascertain, amount to forty-eight square miles, burnt lands amount to fifty. We will add twelve more for the cleared land at Jackman and elsewhere, combined with unproductive mountain top. One hundred and ten square miles of waste are so found, leaving the net producing lands on the drainage at 540. At thirty square miles to the million, we therefore get eighteen million feet of spruce as the yearly growth on the drainage, the amount which as a yearly cut, the land would permanently maintain. At the present time the yearly growth is probably greater because much of the territory is not yet cut as severely as the land upon which our figures have been based. On the other hand by closer cutting the yearly growth might be pushed down. I have been speaking of the yearly growth on the drainage were it all cut to the same standard as the harder cut towns, and were this cut followed up at not long periods by others of a similar character.

Forecast.

Now the saw timber standing on the drainage of Moose river according to the best information I have been able to get together, amounts to something like 400 millions. This is lumbermen's estimate, and it may be counted on to underrun the truth. It includes spruce and pine. The logs cut on Moose river, ascertained from the log-driving company, have averaged for the last seventeen years between thirty-nine and forty millions, which gives us standing about ten years' supply. Growth considered, however, it will be some years later before this cut, even if confined to its present standard, will of necessity shrink. The time is not far distant, however, probably not more than twenty years at the most, when the yearly cut will have to come down—if the figures stated in this study prove correct and no change is made in the policy maintained toward the land—to about half its present figure. The time might, of course, be postponed still further by stripping the land of small stuff—robbing the mine, as a coal miner would say—but that fate, let us hope, is never to overtake the Moose river. It could only be at great expense to future supply.

This shrinkage of the annual cut seems inevitable, but it will hardly be so disastrous a matter as many now seem inclined to think. Pulp mills, it is likely, will then use the great bulk of the spruce, saw mills gradually yielding place to them with little loss of property or distress to labor. This is so because a saw mill is a comparatively cheap affair, while the conversion of a thousand feet of spruce logs into pulp—to say nothing of paper,—costs several times as much as does its manufacture into long lumber. Then, too, it seems highly probable that within twenty years our hard woods will be largely utilized and their manufacture offer full remuneration to capital and labor. If that is the case, the region of Moosehead lake and the Moose river towns along the Canadian Pacific Railway cannot fail to share in the new development. All-round lumbering of that kind might be so managed as to work to the advantage of spruce.

It will do no harm to repeat some of the things that have been said in general about the Moose river basin.

General characteristics of Moose river summarized.

The country is in the first place comparatively smooth. There is, therefore, little waste land in the shape of mountain tops, while the standing timber is easily brought to water. There is a further advantage, too, in less danger from destructive winds.

Secondly. While the country is not rough in its major features, in its detail it is almost always uneven. Good drainage is thus provided, and this feature aided by the presence of the softer rocks and of soil which almost always is abundant for spruce and frequently deep and rich enough to produce good farming land, makes the territory as a rule very thrifty.

Third. In addition to these features the Moose river basin has a great advantage, from the point of view of the future production of spruce, in the mixture of its growth. The lower towns on the river tend to black growth. The upper towns on the other hand are covered predominantly with hard wood. Generally, however, there is a strong mixture, the proportion of young spruce on the upper territory being so far as could be learned almost uniformly high. Continued production of spruce is thus assured, while there is the further and very great advantage that culled-out growth does not so much blow down.

Fourth. The growth on the river if it were all cut by current methods to a close saw log standard and kept so cut has been set at a little less than twenty million feet per year, or about a million feet for a full town. Probably growth at the present time balances more than half the cut. By a little management for the purpose in systematically leaving young timber to grow and in such favoring of young trees as would cost no more if only men are trained to it, this yearly growth could, I believe, be largely increased.* On the other hand harder cutting if introduced and continued can push the yearly growth down till it reaches a very small figure. Growth is like interest. If a man's investment is small, no matter what the rate, his income is of little amount. Hard cutting of one species indeed might be so continued as almost to blot it out of the country.

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*A year later, after a season's study of the German methods of handling forest land, I feel like being bolder and more definite in all statements of this character. I think that by the introduction of economical and carefully studied management, the principles of which might well approve themselves both to German experience and American common sense, that the production of the Moose river drainage could be kept at double the figure named. That means two million feet per year per township instead of one, and a permanent maintenance of the recent average cut of the whole drainage. This I mean as a practical proposition. I do not have in mind tree planting or pruning or any other such expensive processes as are attached in the popular mind to European forest methods. I mean only economical, conservative, studied handling which it would be for the interest of the owners of expensive mill plants dependent for their raw material on spruce to maintain. It seems strange, yet I fully believe it to be true, that the recent yearly cut of 120 millions on the Kennebec, a cut that has stripped the drainage of its old spruce timber, that has sent men scouring parts of the river after poles that won't near hold a man's weight above water, that has shoved the producing power of the land down to a fraction of what we take from it—strange to think that this amount of lumber the same country if from the beginning it had been treated with conservatism and care could readily grow. Yet it seems certainly to be so. The recent annual cut of spruce amounts to less than sixty feet per acre on the total natural spruce—producing area of the drainage, while the total cut thus far can hardly make an average of more than two M. These facts speak strongly for the way in which we have wasted the resources and damaged the capacity of the land.

The Moose river finally is a highly favored timber country, the most valuable for its area that there is on the Kennebec. Its economical treatment, the careful use of its natural resources, its protection from fire, and the utilization of its capacity for growth are matters which not only concern its legal owners, but are of moment to the people of the State.

ROACH RIVER BASIN.

The Roach river which runs into Moosehead from the east, drains the greater part of six townships, an area of about 125 square miles. Compared with the Moose and Dead rivers it is, therefore, but a small basin, and as from previous visits I had a fair idea of its topography, I had intended to take its timber history and condition on hearsay. Dissatisfaction, however, with the work already done, a sense of its inaccuracy, and the feeling that some piece of land ought to be explored in a more systematic and thoroughgoing way than had yet been done, kept me longer in the Moosehead country than was at first intended. Ground could not be re-traversed, however, so boating across Moosehead and then striking across country from above Kineo to the farm on Lower Roach pond, three of the townships on the river were subjected to a somewhat careful examination.

I, R. XIV. Topography, etc.

First and most thoroughly covered was I, R. XIV, made up of the Blake and Spencer bay tracts so called. This is a town of uneven though not rough topography. The only mountains near are the Big and Little Spencer lying just off the town to the north and northeast, too far off to make the town at all mountainous in character, while lifting its northern edge into two waves of high, hard-wood land. In this report we will confine our attention to that portion of the township which lies north of Roach river and east of Spencer bay and pond. Of this territory, the northwest portion, about eighteen square miles in area, with a considerable territory of Middlesex, drains into Spencer bay and pond, the southern portion, in respect to both water and timber is tributary to main Roach river, while a considerable district in the east hauls into Lazy Tom stream. As to timber a great variety of conditions is exhibited. Cutting of all dates and kinds is found, while a considerable tract in the northern portion never was cut and is in its original condition.

Growth after an early fire.

Coming from the west and crossing Spencer stream to enter the tract, the first thing that is seen is an old second growth after fire. The bounds of this are perfectly evidenced to the practiced eye, not indeed as might be supposed, by the size of the trees, but by the kinds of trees that are of large size. There are no large spruce and hemlock on the tract, neither is there any of that old growth hard wood so characteristic of our country. Beech, smallish yellow birch and maple there might be in places, but a far more abundant growth was white birch. Trees of this species were noted as large as twenty inches in diameter and seventy feet and more in height, about as large a size probably as they would ever attain. Indeed, the white birch on this tract had long ago passed its prime. Numerous birch trunks lay rotting on the ground, while of its companion species, poplar, the same thing was to so much the greater extent true that far the larger part of the original stock of trees appeared to have died. Conclusive proof that this was second growth existed in the even number of rings seen in the stumps found, while the cause of it was indicated by blackened pine stubs that careful looking disclosed on the ground. Plainly the prehistoric forest was by no means free from fire.

From the looks of the country and the grain of the trees, it appeared certain that about 110 years ago fire swept over this land, and that a new growth came up after it, in all probability much different in character from the old. Much of the territory as has already been noted, came up predominantly to hard woods, in which white birch and poplar were prominent features. More of it, however, was spruce with a mixture of pine. The latter on liberal soils and in fairly thick growth, had reached a height of ninety to one hundred feet, and had furnished already logs of considerable size. The spruce, on the other hand, had just reached in such places a pulp-log size, ten to twelve inches in diameter by about sixty feet high being a fair size for the larger and more open trees on such ground. On rocky and poorly drained land both species shrunk, the injury, however, being especially evident in the pines.

But the value and producing power of second growth like this is a problem by itself, quite different from the main one we have been considering. Statement and discussion of some figures gathered at this point will be found in the appendix to this report.

Exploration, character of country and stand.

The township was really first attacked from the east. Coming off Spencer mountain which had been climbed for a bird's-eye view of the country round, on the evening of August 21st my temporary companion and I reached an old camp not far from Lazy Tom, assembled enough of an old stove to build a fire in, and taking the chances on some ragged pieces of blanket we hit upon obtained a sheltered and comfortable night's sleep. In the morning we struck directly north through the old works, counting and estimating, completing then and later a line of exploration up through the east side of the town, a mile from its eastern boundary.

On this course a portion of the uncut timber was passed. In this there was great variety, due principally, as it appeared, to the lay of the ground. The ground was seldom level, so that there was little of the thick, stunted spruce often seen, due apparently in most cases to defective drainage. Much of the country was broken in surface, with very little soil, and on such ground a thick stand of smallish spruce timber was generally found. Situated as it was, most of the territory was fairly thrifty, and if opened up by cutting a good increase on the timber left could be expected.

Leaving a considerable body of such growth to the west, northerly travel led us next into mixed growth on rougher land, with generally a more liberal soil. A stand here of perhaps half as much spruce as was characteristic of the other territory was made up of larger and finer trees, which also were more rapid growing. Passing on, we got into the northeast angle of the township, lifted up on the hips of Spencer mountain and covered with a fine growth of hard woods in which only scattering spruce was found. Some areas were nearly devoid of it. Judging from count of trees over a considerable portion of the distance travelled, it was judged that for the northeastern square mile of this town the spruce standing in this its virgin condition was about one thousand feet B. M. and 300-400 cubic feet. Should the saw logs ever be cut out cleanly, perhaps 150 cubic feet might be left.

Catching the middle east and west line of the town in the course north, and keeping run of the distance travelled by pacing, when the north line was approached the course was turned west and the same tactics followed. My companion was an experienced explorer and lumberman whose judgment was good on merchantable timber. I was training myself on that by him and using besides my own methods of observation on small growth. The first mile or so was, as mentioned, through hard woods. Then a swamp area with mixed and valueless growth was passed. Following this came again the belt of timber, swung round from the southeast where it had been passed in the morning. A quarter of a mile of thick spruce on mossy land, was followed by a fine heavy growth of mixed spruce and hard wood in about equal proportions. Just a mile this was travelled, the amount of spruce varying as was judged from two to five thousand per acre. A strong mixture of it was everywhere present, and standing as it did on smooth land sloping easily to water, this was valuable timber. It is just such mixed land, land with a good stand of merchantable timber, and yet with enough hard wood to prevent blowdown when the spruce is cut out, that according to my ideas is most valuable for growth and as a source of permanent spruce supply.

Old cuttings. Great difference among them.

About a mile and a half from the west end of our line on the southeast corner of Spencer pond, cuttings were met with. Right about here the cut had been for some reason extremely close. The country presented an entire contrast with the original growth that had just been passed. Great gaps had but a few trees standing per acre, allowing a long unobstructed view. Out of what must have originally been a fine and heavy stand of timber it was estimated that in the cleaner cut regions not over 200 cubic feet were left on the ground. Other and earlier cutting, while perhaps full more wasteful in its way, had not gone over the ground so closely and left standing perhaps double that amount. As little actual care for the future propably had been exercised in one case as in the other.

Best system of exploration.

It would be useless to weary the reader with long accounts of the detail work. The result of it is the thing wanted, while certain principles which guided it are well worthy of distinct formulation. The latter are as follows: Cruising a town, if it is not guided by lot lines, and especially if it is hurried and merely aims to get at, in a general way, its stand and condition, is best done in straight lines. Three or four trips across a town will give a man a good idea of how the land lies, and even though it may be hacked and gashed in cutting that much systematic travel can be depended on, checked in the ways which common sense will suggest, to give an approximate notion of the amount and character of the timber. By that means, too, the explorer is kept out of roads. Much, no doubt, may be learned by the thoroughly practiced eye from roads, but the man who wants to learn what timber there is on a township had better keep out of them. No man in a strange country can keep run of his whereabouts if he is following the veerings of a logging road. Further than that, he does not see a fair sample of the country. Cutting is always cleanest along a main road, while between systems there is sure to be left more or less of standing timber. These the explorer, unless he strikes out regardless of the traveling, will be sure to miss.*

So it is that a guide who knows a town is often a disadvantage to a stranger who wishes to get acquainted with its features and condition without the expenditure of too much time. Such a guide takes a man either where there is no timber or into the best bunches. He knows the short cuts and the good travelling too well, and while he may sometimes save his man a needless swamp or brush-hole, and he will more times by his knowledge hinder than help the work of getting a clear idea of the land. I found it quite as well, when it was possible, to do alone the exploring that I wanted to do. My conscience always troubled me as long as I was in a road, while to drag a man who didn't see the point of it out through the swamps and brush piles partook too much of the nature of cruelty to be comfortable.

Further exploration.

As to the exploration of this particular tract and the results obtained, somewhat more remains to be said. Some four days were spent on it one time and another. The line already run was followed by another, carried across the township south of the first, while from Roach River House a couple of days were spent in study and travel in the eastern and southern portions. After this the tract and its spruce was summed up about as follows: say five square miles in the northeast part of the town which has never been cut into. Of this, about one square mile is hard wood land with a small mixture of spruce, while most of the remainder is covered either with thick spruce growth, standing on mossy ground or else with mixed timber, in which spruce bears a large proportion. Some three square miles of irregular shape in the west part of the town is covered with second growth about 110 years old, of which area perhaps a half is covered largely with spruce. The southeastern corner of the tract with the neighboring country on I R. XIII, is flat, rocky land with deep moss cover. The spruce that stood on it has been cut through, but never cleanly and most of it some years ago, so that considerable timber, mostly of the smaller sizes, still remains. The average stand of spruce here was set at 800 cubic feet. Perhaps six square miles, more recently cut, is broken land, well drained and of thrifty growth, while the three required to make up the total area of eighteen square miles is land in which hard wood predominated, which has been cut through and which now has on the average some 300 or 400 cubic feet of spruce per acre. This too is of course quick growing land.

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* Judge Buswell of Skowhegan first gave me these ideas about exploring. They were thoroughly tested in my own work.

Results. Estimated stand and growth.

The same facts and estimates are next put into tabular form.* They may mean little to the reader, but such facts are essential if we are to ascertain the amount of growth on our country. In this connection it is not so much the amount of merchantable timber standing which tells the story, as the amount of small timber and the thriftiness of the land. The growth calculation will not in this case be given in detail. I will only say that as near as I can judge the yearly growth on the ten square miles of cut-over land, made up of items two, five and six, is somewhere between 400 and 500 M. feet B. M. This is considerably more per acre

I, R. XIV, NORTH OF ROACH RIVER AND EAST OF SPENCER BAY AND POND.
AREA, CONDITION, AND ESTIMATED STANDING SPRUCE.

	Square miles.	Acres.	ESTIMATED STAND IN CUBIC FEET.	
			Per acre.	Total.
Hard wood land, etc—uncut	2	1,280	400	512,000
Mixed land, cut out	2	1,280	400	512,000
Second growth	3	1,920	600	1,152,000
Timbered land, uncut	3	1,920	1,500	2,880,000
Spruce land, flat, slow growth, cut	2	1,280	800	1,024,000
Spruce land, uneven, quick growth, cut	6	3,840	700	2,688,000
Total	18	11,520		8,768,000

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* This computation is later upset by a fire which ran through the tract in the spring of 1896. Territory covered and amount of damage not yet known to the writer.

Practical inferences.

than the production of Dennis and Brassua, a fact which is due, not to greater thrift, but to the larger amount of timber which looser cutting has left on the land. This is thought to be about twice what it was in the former case. The fact points what was lately said about the allowance one has to make for the man and his methods when told that a piece of land has been cut clean.

Contrast in cutting methods.

The next two townships to be explored are of particular interest from a new point of view. These are the Bradstreet town and No. I, R. XIII. They lie next to one another, and are not specially unlike in topography and other natural conditions. Both, on inquiry, will be called cut-over towns. Yet note the difference in their condition as shown by a brief account of travel upon them.

Land cut by its owners.

The Bradstreet town so-called is the north half of A R. XII, and the south two miles of I in the same range. It is owned by the Bradstreets of Gardiner, and was cut by them for saw logs for the supply of their own mill. After some desultory cutting by previous owners it is said to have furnished to them a cut of six millions a year for ten years. Uneven in surface, even rough in the southern portion, there is a considerable variety of land on the tract. It is, however, finely situated for lumbering. The Roach river and ponds lie across the middle of the tract its longest way, and all except perhaps a couple of square miles of its area comes easily to some part of this water with a haul of at most three miles. But the main point for the present is that the township was cut by the owners, with their own crews, for their own mills.

The effect of this was seen at once in the close, systematic work done. The first jaunt on the town took me south from the farm on the second Roach pond onto the mountains which lie south of the second and east of the first Roach pond. The mixed growth on these mountain slopes had been well cleaned of spruce. Scattering logs only were to be seen, these being mostly in some deep brook gully or on precipitous slopes where teams could hardly get them. Climbing onto the nearer peak, which, unless my aneroid served me a trick, is nearly 1,300 feet above the ponds, the old works were still found, coming slantingly up the steep ground to near the top of the mountain, as far, in fact, as any lumber had ever grown. Looking the country over from the top of a tree, an east course was next set, which carried me across the Katahdin Iron Works' tote road (the old highway of supplies for Chesuncook and Chamberlain before rail was laid to Greenville) and through to the shore of Trout pond.* Thence a turn north and another west took me back at night to my pleasant boarding place at Mr. Stirling's farm. All the way it was the same. Up on the mountains and everywhere else the crews had been sent, and their cutting was systematic and hard. Bunches of log trees were few and small. Covered originally with rather a heavy and even stand of timber, the 400 cubic feet remaining in all sizes could hardly have been more than a quarter of the spruce that was originally on the land.

So in that portion of the tract lying north of the river and pond. Two days travel were put in here, and the larger part of it found to be in about the same condition. The best of supervision had plainly been employed. The men who cut the land owned it, and the lumber they wanted for the supply of their own mills.

Land cut on stumpage permit.

Great was the contrast seen on I, R. XIII. Who the owners of this township are I do not know.

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*One of the largest forest fires of 1895 occurred in this region, and a record of the circumstances attending it may be of some interest and value. The writer was on a portion of the burn August 26th, and roughly mapped its western portion. The fire was still smouldering, even after frequent and heavy rains. The following facts are learned from Mr. F. H. Stirling, who lives on the shore of second Roach pond, within a few miles of the burnt area. The fire started June 13th in old burnt land between Trout pond and third Roach pond, being set, in all probability, by lightning. It ran swiftly that day but the next was checked by a heavy rain and could then and for some time after have been handled by a crew of men. Mr. Stirling notified the owners of the land in which the fire started, also the nearest fire warden. Neither, and no one else, paid any attention to the matter. Mr. Stirling, with his two hired men, saved the supplies stored in a camp that was burnt, and spent some little time trying to prevent other damage. Up to the date when he was seen he had received nothing from any source for his labor and time. The burnt area, so far as it was overlooked by the writer, was thought to be at least 10,000 acres. The rains of late summer put the fire out.

Certain it is they are neither lumbermen nor mill owners. The township has been cut on stumpage permits.

This town was not systematically explored, but at odd times and by the way a good deal was seen of it. The road between the two Roach river farms goes across the south end of it. Leaving the lower farm, the country for the first two miles is field, pasture or else small second growth which has come up after clearing and fire. Several square miles, in fact, in the southwest portion of the town are second growth. Further east on the road one enters timber. Years ago it was cut through, but never systematically, and there is now standing a very fair amount of spruce timber.

But the real condition of a township is not to be seen from roads. The points that I want to make here will best be brought out by recounting some of my travel. For instance, on the morning of August 19th, I started out from Roach River House, and traveling up the Grant farm tote road to a short distance beyond that backwoods edifice which is locally known as the 4-mile shanty, I struck off into the woods in order to see a little of the country. Holding an east course by the compass, the first 400 steps took me through very old cuttings where only the best of the timber had been taken. Detail count by quarter acres indicated a stand of 100 spruce trees six inches and over in diameter per acre, in volume about 1,500 cubic feet. This means probably 3 or 4 M of smallish saw logs. Then a new road was crossed, hauling south, the builder of which perhaps thought this bunch of timber beneath his notice, or more probably was saving it for another winter. Mixed land followed in which, however, the count disclosed some 50—60 trees, or 800 cubic feet of spruce per acre. This lasted to a distance of half a mile from the main road. Then for a quarter of a mile the course took me down hill, through hard wood land whose mixture of 1 to 2 M feet of saw logs the operators had thus far entirely passed by. This brought me to flat land and black growth, where for a third of a mile stood an average probably of 5 M of spruce, mixed with scattering pines of large size, but poor quality. No axe had ever been struck into it.

To this black growth succeeded a genuine swamp. It was full of poor cedar, hackmatack, and stunted spruce, was a quarter of a mile wide, and extended N. N. E. and S. S. W. as far as could be seen from the top of one of its tallest trees. Getting out of that, higher ground was struck, again a spruce country, where cutting had for a space been followed by clean blow-down. Clambering through this, virgin timber was soon seen to the right and after several hundred yards my easterly course brought me into it. Then for a mile I travelled in ground of varying character and value which, however, had never been cut. Most of the land was mossy and rather flat, covered with an open stand of spruce and pine running several thousand feet of saw logs per acre. A little had spruce and hard woods mixed. An area was flat, deep-mossed land, with poor drainage and stunted timber. How big a territory there was here I cannot say. The swamp was not very far to the left. Old cuttings, too, were somewhere to the right, for at two points the head of the works barely touched and crossed the course I was running. No impression, however, had been made on this timber. The lumberman, working on a stumpage permit which left him free to go where he chose, probably driven, too, by the price of stumpage and of logs to use every advantage of his position in order to come out of his little enterprise whole, had simply struck for the bodies of timber which were thickest and most available, leaving the corners and thin places to take care of themselves. Yet this town, like the Bradstreet town, men will tell you has been cut over. It is being cut now for the second time.

Inferences from the facts recounted.

The facts just stated—and they are thoroughly typical—throw light on several matters that it is worth while to point out. For one thing they help us to see how the rule arose that land can be cut over every twenty years and a crop of lumber obtained. Of course that is so if a man cuts in the way described. The same thing could be done every two years for that matter as long as it lasts. Of course the cut of timberland has overrun all estimate when that has been based on such inadequate methods of lumbering. The first explorers, and some of more recent date as well, made no account of timber unless it was both thick and large, and when in the course of time all timber became valuable and was utilized, men laid to growth what really had always been on the ground. In that way men have fooled themselves about the supply and growth of timber, vastly depreciating the one and often as greatly multiplying the other.*

But we should miss the main point if we stopped here. These facts, when rightly interpreted, contain a lesson for our census makers and our other official and scientific authorities. In their investigations of our timber resources, they have so far for the most part contented themselves with second-hand information. The partial knowledge and rough guesses and notions of such lumbermen as were handiest have been put together, stamped with an official seal or the authority of a well known name, and passed out upon the country as timber statistics. And the point of this little study of two tracts lying side by side, of which one by inquiry would get much the same account, is that facts gathered in that way, unchecked by actual knowledge of the woods and of lumbering, are actually of not the least account. If any man doubts that let him go to the tenth census, to that great volume on forest trees which lays claim to monographic completeness, and see how the figures for Maine and the forecast to be based on them have come out. The difficulties of such census work of course are great. But if those difficulties are not to be met, if the only result of such work is to mislead and to scare us, then we certainly will be better off without it.

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* As an example of this, also as illustrating the accuracy of current ideas as to growth, I will recount the estimates of a wealthy land-owner and successful business man of Calais on the growth of the St. Croix river. Taking as a starting point the original estimates of the St. Croix townships, with the date, he reckoned up the amount of timber cut on the same townships to the present time, added the estimated present stand, and by subtraction obtained the amount of growth meanwhile. It amounted to 400 feet board measure per acre and year.

One way to collect timber statistics.

That what has been said about this township is not at all an exceptional thing, all careful observers, especially those on the Penobscot river, can testify. My trip across the north end of the township showed the same thing, this being taken not so much for this purpose as to get onto Spencer mountain for the bird's-eye view of the country. This time I had a companion in the shape of a young and active Penobscot lumberman. He carried a tent and blankets in the most compact form known — that of an axe namely; I had my calipers, while the crackers, pork, tea, and extremely suspicious looking meat with which we had been provided was divided between us. We climbed the mountain, traversed the Lazy Tom country, crossed Spencer Bay town to Moosehead lake as already noted in these pages,— spent, in fact, four very active and delightful days together. When night came on we would pick a chance beside some brook, get down enough wood to keep a good fire going all night, and lie down under the open sky, first to talk and then to sleep. I recommend this style of camping to all who want to thoroughly enjoy the woods. The only drawback about the sleeping accommodations lies in the fact that if the weather is cool, and one is at all uneasy, he is likely to roll over in the night and stick his feet in the fire.

But to get back to business. Returning on the Grant farm tote road to a point within I R. XIII, and striking westerly by the compass so as to keep well within the limits of the town, hard wood with very little spruce was traversed for a mile. Then we waded Bear brook, after which came a burn of twenty years ago, noted the day previous where it crossed

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I can illustrate by another example the untrustworthiness of hearsay in regard to timber. A mountainous tonwship was was cut through some years ago for its best and handiest spruce. Plenty of men, men that helped cut it, think and say all the timber was got; and conversation with the owners, unless with a view to purchase, will not reverse that idea. As a matter of fact no portion of it was cut clean, while great bodies of high and rough land, covered with magnificent spruce, were left entirely untouched. Parties have desired to buy it on the basis of estimates of more than forty million.

the tote road. Next came a strip of spruce timber left by some combination of circumstances on the north line of the township, to which succeeded a territory that was once heavily covered with pine, where, after the cut of many years ago, the little remaining timber had blown down. Much the same thing was to be seen for three miles, and it had also been found on large areas the day before. The early cutting of pine or spruce as the case might be, had left the remaining growth in such shape that the winds had levelled it and the ground was left to cover itself afresh. There was, let me say, no need of planting trees there. Mixed hard woods, among which white birch was most prominent, filled in underneath with small fir which here as almost always was mixed with a proportion of spruce, formed generally a dense cover to the ground.

Finding at length that our westerly travel had brought us nearly south of Spencer mountain, we shifted course for it. The blowdown was soon left behind, then a spruce country succeeded which had been once and lightly cut through. This soon and rapidly improved, and very soon we found ourselves in what must have been a sample of the finest and thickest spruce timber that ever stood in the region. On smooth land easily lumbered, with soil fairly liberal and moss-covered, the growth was large fine spruce with only an advantageous mixture of other species. My man was in the air right away. If he could only get a permit, he would go into business for himself, and thought he could soon make a fortune. Accustomed to cut only saw logs of large size, on the rough and distant lands of Sourdnahunk and the East Branch of the Penobscot, he thought this country would run seven thousand such logs per acre. Cut and scaled as I have seen lumber cut and scaled within the limits of the State, I am confident this territory would yield twice that amount.

What may be on a "cut-over" township.

It was not our business to trace up bunches of timber like this. We had no time for it. For a mile in a straight line it lasted, and there was no great variation. At last, on the skirts of the mountain, we ran out of it into a growth predominantly hard wood. This piece of timber was located where it could be hauled either way,—into Penobscot or Kennebec waters,—and that fact perhaps, complicated by the owner's preferences, had saved it to the present time. It is introduced here mainly because it shows what may be on what is called a cut-over town in some portions of our State. One never knows till he looks it over what a township treated like this has on it. A second cut, if thorough, sometimes yields more than did the first.

Wastes of the stumpage system.

What further inferences different readers may draw from this record of fact observed I may not be able to guess. To many lumbermen this will seem a perfectly natural and fitting condition. Forestry agitators on the other side may adopt quite as extreme a view. There certainly is great waste in our methods of lumbering. Some directions in which this takes place have not yet been referred to. The waste which is here most plain on the surface is the cutting of timber in such a way that what is left blows down. Great values are lost in this way. As I think over what has been seen during the season's travel, it certainly seems that the loss through wind in the great forest areas of the State is greater than that caused by fire. Study of our forests and education of our lumbermen will remedy much of this loss. Much, however, cannot be remedied, and in one sense does not require remedy. The bounty of nature in setting at our hand greater supplies, when all are considered, than we are yet able to utilize, forces into our business methods much waste and loss. To talk of European economy for the State of Maine is folly.

But there are wastes here which are needless and glaring, and the conditions under which they occur must not be allowed to escape us. Not only is timber cut without regard to the future of the land, but with little reference to getting the full benefit of what is now on it. Little more than half of what is killed is utilized. The land is hacked and gashed, not sytematically cut. The thick bunches are taken and that nearest to water. Other land covered with timber which perhaps needs the axe to save it from decay, is allowed to lie fallow because it is more distant, or its timber is scattering. If taken out later, that is done at greater expense.

Now much of this again is unavoidable, for the reason just stated. As our lumbermen have moved back on our waters, carrying the border of profitable operation gradually back onto more distant and difficult land, they could only take at each step the best and the nearest. But now that all our timberlands have gained a value, now that we are inquiring and with need if our supplies of some kinds of lumber are long to be maintained, some of these wasteful methods ought to be abandoned. Much of this is due merely to our business organization, to the fact that the interests of the man who cuts the lumber are divorced from the interests of the land. I trust I have made clear by concrete example the difference there is when the man who owns the land cuts it, and when a land owner sells stumpage to a man who cuts the logs without hindrance or supervision. From the mere statement of the case it must be so. The operator strikes for the bunches and leaves the scattered timber. He cuts the land for the best only and butchers the rest or leaves it to blow down. He tops his logs off short for scale, *and leaves the tops to rot in the woods. All this the man who owns the land and cuts it himself avoids. Wherever there is timber that will pay for hauling he gets it. His interest prompts him to leave the land in as good shape as he knows how. If he is a mill man, and modern economy has been fully followed, he can use the knotty top logs. When we come to the Androscoggin these matters will again crop out. If after that I could give the facts about a genuine Penobscot town, could give the history of the cutting and utilization of its lumber, recounting also its present condition, the contrast would be more marked than any which has yet been brought out in these pages.

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*See page 50, note, for an illustration.

Don't blame the woodsman.

I cannot leave this subject without warding off blame from the head of the lumberman, the hauler of the logs. The fault, if fault there be, does not lie there. The style is set for him, and one man cannot change it. He is generally a poor man, the weak party financially in the trade. Ground between an upper and a nether millstone of price of logs and of stumpage, threatened, too, by a method of measuring timber which keeps him in uncertainty and very likely may more than offset his stoutest efforts, he has to use, to assure himself of a profit and a living, all the advantages of his position. The cause lies with the land owners and the system of absentee landlordism which they maintain. Men of capital who have found out that timberland is a safe and paying investment, in most cases their lands have been bought on other men's judgment. Oftentimes they have never seen their property, and many of them would not know what to make of it if they did. The connection they maintain with it is simply to charge and collect the highest market price of stumpage.

Now there is no way in which this matter can be externally remedied. Knowledge of the facts, however, may help to some extent. Knowledge of what is lost may cause land owners to look after their property more carefully. But there is a further idea to be drawn. All who desire the economical utilization of our forest lands should welcome their movement into the hands of those who are to cut and utilize their prdeuct.

Outline of further exploration.

Readers, if any have followed thus far, have learned the main principles and a share of the facts on which judgment is based as to the spruce producing power of the Kennebec river. Not that all facts observed in travel have been recorded, nor that travel on the drainage was confined to that which has been described. The Roach river exploration was followed by a visit to Misery and Sapling, while two days were spent on different parts of Squaw mountain. Exploration for that time ended at Parlin Pond, whence stage was taken for the railway at Bingham. Later in the season again, in November, after the exploration on the Androscoggin, the townships of Reddington and Coplin were traversed, a jaunt taken over Kennebago mountain to Tim pond, and Eustis visited, thus covering part of the upper waters of Dead river, which had been skipped in the spring. Then three days were spent in travelling afoot from Stratton, round through Jerusalem and Kingfield, to Salem on the head waters of the Sandy river. On this route the burns and second growth were mapped, some of the spruce territory hastily looked over, and enquiry made of residents as to the timber condition of the country. This was essential to the statistical portion of the work, while here as everywhere else during the season's travel points full of interest and suggestion were always outcropping.

Elevation and temperature.

It may be worth while to relate a little incident which forcibly illustrates the effect on climate produced by a few hundred feet of elevation. At Stratton I was delayed for two days by the long postponed fall rains. When the rain stopped it was followed by colder weather. Starting out again on Monday morning, the 11th of November, the first thing I did was to climb the western peak of Bigelow, whence a fine view and one very useful as well to my mapping work was obtained over the whole surrounding country. The value of the second growth here, by the way, is well worthy of remark. A considerable area of pine in Eustis and large quantities of fine white birch all through the country—this growth having sprung up on the burns of many years ago—both promise and possess a large lumber value. Now when I got perhaps 1,200 or 1,500 feet up the mountain, I found the trees covered with ice. At the top of the mountain, every twig and blade of grass had an icicle about it more than half an inch thick, while the limbs of the firs and spruces were solid clubs. Plainly, during the last of the rain, it had been enough colder up here on the hills so that the drops froze as they fell.

On each of the next two days I climbed to a point about 2,000 feet above the general level of the country. The first day it was the highest peak in eastern Jerusalem or Treadwell township. The second day it was Black Nubble near the northwest corner of Kingfield. Locating myself in one way or another, the burns could be sketched and the condition of the country approximately noted. But each day when I got up about so high, I found the ice. It remained as long as I was in the country.

I couldn't help thinking of Mark Twain while I was up on those mountain tops. If he had been there about noon some day, when the trees were dripping both ice and water, and a man couldn't stir without being wet to the skin, we might perhaps have had a striking postscript added to his description of a New England ice storm.

This of course is but one of a thousand perfectly plain demonstrations of the effect of elevation and exposure on temperature. The general effects of these conditions on the distribution of tree growth are no less evident and well known. Many notes relating to it, rendered much more worth while by aneroid observations, were taken during the season's cruising. There is hardly enough of them yet to put on record, and they do not strictly harmonize with the utilitarian nature of this report.

SUMMARY ON THE KENNEBEC.

Probably as much has now been said as can well be put in narrative form. It remains next to gather statistical information, and draw such conclusions in regard to the lumber business of the Kennebec as it appears may safely be drawn. After that we shall go on to other territory, returning later to the discussion of some topics and suggestions which have not yet been sufficiently followed out.

The first thing that is essential is statistical knowledge as to area and condition. The total area drained by the Kennebec river, according to Well's survey, is 5,800 square miles.

Spruce-bearing area.

Of this only about half has to be considered in connection with spruce—its more northern and higher portion. By this it is not meant that there is no spruce south of the line of division drawn. Spruce goes clear to the southwestern corner of the State. The question is one of practical timber supply for the Kennebec mills, and with that in view our dividing line is approximately correctly drawn. Whatever may be derived from territory below it is not great in amount. Most of it probably is wanted for local consumption. It can be estimated by those familiar and concerned with the country in question as supplementary to the area dealt with here.

Sub-division.

The northern spruce-producing portion of the Kennebec has, exclusive of Moosehead lake, an area of 2,820 square miles. This area has, for the purposes of this study, been divided into five districts, the names and area of which follow:

		Sq. miles.
1.	Drainage of the Moose river	655
2.	Drainage of Roach river and Moosehead lake . .	430
3.	Drainage of Dead river	820
4.	Tributary to Kennebec river below Moosehead as far south as Moscow and Mayfield	580
5.	Part of drainage of Sandy river and Carrabasset *	335
		2,820

Deductions to be made.

In the further development of the subject the next step is the deduction of those areas which, so far as the spruce supply is concerned, are waste land. For the present purpose the following table gives us the essential facts. Among the items of waste land, water and bog areas are classed together, old burnt lands and settled land as well. Most of the newer burnt lands were burnt within the last fifteen years. In this connection especial attention is called to the amount of burnt land on the Dead river. The waste from mountain top is a pretty unreliable figure.

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* Northern and more mountainous portion including on the south Lexington, Kingfield, Mount Abraham, Madrid, Letter E and No. 6.

	Drainage area.	WASTE FOR SPRUCE.				Producing area.	Per cent of same to total area.
		Water and bog.	Burnt under thirty years.	Old burn and settled.	Mountain top.		
Moose river	655	48	50	4	12	541	.83
Roach river and lake	430	19	22	16	6	367	.85
Dead river	820	33	218	86	19	464	.57
Main river below lake	580	31	2	102	3	442	.76
Sandy and Carrabasset	335	4	23	143	15	150	.45
Total	2,820	135	315	351	55	1,964	.70

These figures are worthy of careful study, the figures particularly for the different sections of the country, to those whose interests attach to them. Detail figures for each township are behind these summary ones. For various reasons it is not intended to give these publication in this report. That, indeed, could best be done in map form.

Area hard wood and blowdown.

In addition to the facts here tabulated there are others which affect the problem of growth materially. Among these may be mentioned the area of blown down timber, which is very considerable, and the proportion of the country which is pure or nearly pure hard wood. In regard to these matters no tabulation will be attempted. For areas which were explored the facts are approximately known, and they have been allowed for. For other regions the results of inquiry have to be taken, supplemented with what could be learned through occasional views from mountain tops. For all facts of this nature relating to the question of spruce supply—the proportion of hard wood land, the mixture of young spruce in the cut-over lands, the proportion of black growth and its degree of thrift—constant watch has been kept thoughout the season. Of the several districts into which the Kennebec drainage is divided, the territory tributary to the river below Moosehead is the only one of which not enough was seen to form a pretty good general notion at first hands of its character. This whole matter, however, must be brought into the problem more in the way of judgment than as statistics.

Area of uncut timber.

Next in order comes the timber condition of the territory. In regard to this, the first question that meets us is the proportion of the total producing area which remains uncut. The figures presented on this point are to be somewhat qualified. Those who have followed the narrative which precedes in this report will perhaps understand what is meant when I say it is often doubtful what should be reckoned as cut and what as uncut land. Again, of that which may be left uncut, it may be a question how much has a large enough proportion of spruce upon it to be worth taking into account in the connection. In this, as elsewhere, it has seemed well to be conservative, and only uncut tracts of some considerable extent have been counted into the list. From the area of these, no deduction has been made for regions which, though reckoned in the account as producing land, may have little or no spruce upon them.

Amount of merchantable saw timber.

Alongside the figures on the last-named point are put such estimates as could be obtained of the amount of merchantable timber now standing. These are in almost all cases lumbermen's figures. Such figures have a

VIRGIN FOREST AND MERCHANTABLE TIMBER.

	Area of drainage.	Area uncut for spruce.	Per cent of same.	Millions of saw logs.
Moose river	655	140	21	380
Roach river and lake	430	60	14	250
Dead river	820	140	17	*390
Main river below lake	580	10	2	140
Sandy and Carrabasset	335	50	15	100
	2,820	400	14	1,260

* Includes a considerable amount which the business developments of 1896 turn over to mills on the Androscoggin.

general tendency to underrun the truth. They designate, as I understand it, the amount of saw log timber on the tracts in question, meaning by that, trees that will yield logs say eight inches in diameter at twenty or twenty-five feet. Pulp is not included, and unavailable lumber is not included—meaning by that again lumber that is so distant from water or so scattered that according to current methods and standards it is not worth getting. Reason has been shown in this report why such timber, on the upper waters at least, cannot be reckoned at less than several million feet of saw lumber for each town. This is not included in the estimates, yet in thinking of the future it must be allowed for, aside from its bearing on the growing power of the land. The estimates vary greatly, too, in the care with which they were made, while the views and lumbering methods of different men have very great influence upon them. Considering these facts and the history in general of such figures, I think it highly probable that the same lumber brought to the test of actual cut, or even viewed standing by the more careful Kennebec explorers, would come to as much as two billion feet.

Amount of small spruce.

In regard to the amount of pulp in the country—the small spruce, that is, which is too small to cut for saw logs, but which the pulp mills can very well utilize,—lumberman's estimates are only in a few cases to be had. I shall prefer not to consider this material in the present connection, to consider it not as available lumber, but as material which is left on the land for growth. An estimate of its amount, however, is essential even from that point of view. It is best given not in board feet, the common but variable term of lumbermen, but in cubic feet, a scientific and unvarying measure. I suppose if I set the total amount of spruce standing on the Kennebec drainage at 1,000,000,000 cubic feet, made up one-half of available saw timber and one-half of material which from size, quality and location cannot be so considered, that will mean very little at first sight to any who read it. Certainly little can be claimed for any such figure, only, in fact, a probability of proximity to the truth.

Such a figure, however, is worth setting. If its absolute amount is too great for the comprehension, yet relatively, to put alongside of similar figures for growth and for consumption, it has a use.

In order to arrive at it all that has been learned of the country has been put together—the total area of spruce-bearing land, the nature of the growth upon it, the severity with which in different parts it has been used. Pulp cutting, I may say, has so far been confined practically to the Dead river and to the main river below Moosehead. Some of the towns near the main river, as for instance The Forks and Carratunk are said to have been systematically stripped. The same kind of cutting has partially gone over others. Below The Forks of the Kennebec, there are only one or two tracts said to have now standing upon them saw logs of any considerable amount.

Area cut for pulp wood.

Wholesale figures on the amount of growth similarly are as much dependent on estimate as on computation. On the Moose river drainage in our estimate on this matter we allowed a million feet of yearly production to every thirty square miles of productive land. The same ratio may fairly be extended to the country tributary to Roach river and the lake, a basis of reckoning which sets the yearly growth of the 367 square miles involved at about twelve million feet. Perhaps the same will hold on the Sandy river and Carrabasset. We will at any rate set the yearly growth of this region at five million feet.

Yearly growth.

For the other regions into which the basin of the Kennebec was divided, no such production, I feel confident, will hold. The Dead river at any rate is less evenly timbered with spruce than the Moose river. Neither is it as a rule so thrifty land. It has, furthermore, where it has been cut been cut harder, which, according to principles earlier developed, runs down its growing power. The same things are true in general of the country tributary to the main river.

Perhaps we shall not be far out of the way in setting the yearly growth on these territories at a million feet for each fifty square miles of producing land. This gives us for each of the regions named a yearly growth of about nine million feet. The total production of the river therefore is set at fifty-three million feet.

What is meant by these figures must be as near as possible defined. I mean by it the probable yearly production of each territory named, should cutting continue all over it to the standard and by the methods at present used, but not proceed to a lower standard or to closer methods. Thus the Moose river drainage we will suppose cut all over to a standard of eight inches at twenty feet as cleanly as practical lumbermen now cut. This cut may be followed by others at intervals of ten to twenty years, but not to a lower standard. The Dead river and nearer drainage of the main river may be cut all over closer, and still, according to the supposition, produce the amounts set against them. Harder cutting, if followed up, can, it is well understood, greatly decrease the growing power of the land.

In another direction these figures need qualification. All these figures, whether relating to area, stand or growth, concern only our old-growth tracts, tracts, that is, that were never burnt or cleared. Now the older burnt lands, a considerable portion of which are about seventy years of age, have more or less small spruce upon them, some indeed of even a saw-log size. It is believed, however, that this is not now of much practical account and that many years must elapse before it will be. The pine upon these tracts is greater in amount and value. The old burnt lands of the Dead river region, Moxie gore and other tracts of land in different localities are more or less well stocked with it. This class of timber has been left out of account in this discussion, which has been almost entirely dealing with spruce. The pine, however, on the old growth lands is included in the estimates of merchantable timber from those lands, and in the explorations and computations made, distinction between pine and spruce was not drawn. The pine in these original forest lands, however, is not great in amount. The best of it was cut years ago on almost every township. Probably not over ten per cent of the present stand of merchantable coniferous timber on the Kennebec is of that species. Its proportion in the estimates on that point and also in the estimates of growth is far less than the liability of either to error.

Consumption on the Kennebec.

Next we turn to another phase of the general question—consumption. Some statistics on this branch of the subject are given in the appendix. Here it is only necessary to introduce general amounts. From the books of the Kennebec Log Driving Company, I learn that the cut of the river exclusive of the Sandy river and Carrabasset, whose cut is usually taken care of before it reaches the main Kennebec, amounted in 1894-95 to about 105,000,000 feet.* The average for the last ten years is 137,617,000 feet. Both amounts include all the soft wood timber cut and driven down the river—spruce, pine, cedar and hemlock. The cut of small mills at various points, getting their logs from nearby and selling to a local market, is not included in these figures and has not been ascertained. It can be but a small amount, not over one or two million feet. Neither is the cut of the mills at Lowelltown on the Canadian Pacific included. These are sawing at present nearly twenty millon feet a year, and are entirely capable of taking care of the lumber on the two or three townships in their immediate neighborhood. These and the mill at Reddington, recognized as temporary, for the consumption of the lumber in their vicinity, though it is an item amounting to from twenty-five to thirty millions, it will be easiest and fairest to leave out of account here.

In the lumber driven down the Kennebec, the exact proportion of spruce it would take much labor to learn. Inquiry at the mills, and some figures relating to the cut of the Dead river which are given in the appendix seem to indicate that eighty per cent would not be far out of the way. This leaves us with 84 millions for 1894-95, and 110 as the average spruce cut of the main river for the last ten years. Of this amount about 40 millions, exclusive of some mill waste, is at the present time used for pulp.

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* Including about five millions in 1894 and nine millions in 1895, brought from the Penobscot at Northwest Carry.

Final conclusions.

Putting these figures alongside those for growth recently derived, it is found that according to our statistics and estimates about half the yearly spruce cut of the Kennebec is balanced by growth, while the yearly production is more than sufficient to stock the pulp mills. As these are now the strong mills in bidding for the lumber, the mills too that by reason of the labor and capital employed are of greatest value to the country, this conclusion has great practical importance.

Now it is certain that of the great rivers of the State the Kennebec is that whose timber condition is most critical, the only one about whose immediate supply there has been any well grounded doubt. True the cut has in general for many years past been increasing steadily, but it has been uncertain whether it could be long maintained. Some pressure has indeed already been felt. Some wood has been hauled by rail to the pulp mills of the Kennebec. Within three years a chain carrier and sluice have been built at Northwest Carry on Moosehead to convey to Kennebec mills timber that grew on the Penobscot. Another very significant sign of the last two years is the hauling of spruce pulp wood by the Canadian Pacific from Canada to be thrown into the river and floated to the mills at Madison and Solon. These movements seem to be true signs of the times, for pressure in the market and shrinkage in the yearly cut of the Kennebec is not far distant. What the steps of that shrinkage will be, how much pressure and disturbance will accompany it, remains to be seen. Personally, I cannot believe there will be much, for reasons that have already been partly indicated. The process will probably be slow, and largely offset by developments in entirely new directions. Some of our saw mills no doubt will have to be abandoned, but many of them are old and cheap affairs. To labor I cannot think the loss will be great. To convert a thousand feet of spruce logs into pulp or fiber costs in labor alone, according to my information, somewhere from five to six dollars, several times the labor cost of manufacturing a thousand feet of lumber. The work too is carried on under better conditions, is of a higher grade, and has the advantage of lasting all the year round. This, moreover, is saying nothing of the paper manufacture which, in order to save transportation, is working nearer and nearer to the woods which are its final source of supply. Taking everything into account, it is probably safe to say that the conversion of a million feet of spruce into paper is worth more to the labor of the State than five millions converted into long lumber.

Above all, in concentrating attention on one kind of lumber, we must not forget other resources which, though they may at present have little or no market value, possess, nevertheless, great utility, and will certainly have value and make business in the not distant future. Chief among these are our hard woods. A survey of the country for spruce is a very partial and one-sided affair, dictated by the limitation of time and money. The uniform tendency of the past we have no reason to think will be reversed in the early future. Our forest resources have been taken a piece at a time, and they are yet but partly utilized. The increase of population, the development of transportation and of the arts have given to our timberlands in the run, and in spite of the searching pursuit of some kinds of timber upon them, a constant increase in value.

With so much in the way of forecast and of explanation, it remains now merely to assemble and put in compact form the major results of this study. As this is done, the qualifications that have been made on previous pages must not be forgotten. This work cannot be held to close accuracy—there may indeed prove to be considerable errors in it. The facts obtained are seldom the result of exact record. Sometimes they are in terms which are variable and not uniformly understood. Judgment almost always forms a considerable element in them. Not only is this the case with those facts which were obtained by inquiry, but those which were determined at first hands as well. The work has been hasty. Methods have been crude. The subject is a great one, for handling which there is no precedent. Conscious of many defects in our work, acknowledging chances of error at every point in its execution, the results are presented for what they are worth, with considerable confidence, however, that they will not seriously mislead, in the hope that they will prove of great and lasting value to the business interests of the State.

SUMMARY OF FACTS RELATING TO SPRUCE SUPPLY OF KENNEBEC RIVER.

	AREA—SQUARE MILES.			LUMBER—MILLION FEET BOARD MEASURE.			
	Total.	Spruce producing.	Not yet cut for spruce.	Available saw logs.	Yearly growth as defined.	Yearly cut. Average of last 10 years.	Estimated spruce cut. 80% of last.
Moose River basin	655	541	140	380	18	*37	
Dead river	820	367	140	390	9	48	
Roach river and Moosehead lake	430	464	60	250	12	53	
Main river below Moosehead	580	442	10	140	9		
Sandy and Carrabasset	335	150	50	100	5	†5	
	2,820	1,964	400	1,260	53	143	114

* Not including cut of Lowelltown mills.

† Excluding Reddington. Estimated from very imperfect data.

Estimated stand, growth and consumption in cubic feet:

Stand ($\frac{1}{2}$ in available saw logs)	1,000,000,000
Growth, present yearly, in virgin timber offset by decay	22,500,000
Permanent yearly, equivalent of 53 millions B. M. above	15,000,000
Consumption, comes yearly to mill (equivalent of 114 millions above)	33,000,000
Equivalent in standing trees	44,000,000

SPRUCE ON THE ANDROSCOGGIN.

Area, topography and timber.

The Androscoggin drainage is considerably smaller than that of the Kennebec, while it is less than half as large as the basin of the Penobscot. According to Wells' "Water Power of Maine," the Androscoggin drains in the State of Maine about 2,750 square miles, and in the state of New Hampshire about 850. Of the whole, however, only about 2,200 has to be considered in relation to spruce, for in the southern portion that species can hardly be said to occur as practicable timber. All of the Androscoggin drainage in New Hampshire is, or was, spruce-bearing, while in Maine the region of its distribution may be bounded roughly by a line beginning in Gilead where the river finally enters the state, and running thence northeast to about Phillips on the Sandy river. This line encloses a gross area of about 1,300 square miles.

The connection of the distribution of spruce with the elevation of the land is more evident here than in any other portion of the State. North of the line indicated the country is mountainous. South of it, especially south of the Androscoggin river, the land is comparatively low and much of it even and sandy. Here small second growth pine is found in great abundance. It extends south indeed as near as I have been able to learn over the whole southwest corner of the State. The original growth too was largely pine, while spruce, except for bunches on the mountains and in the swamps, seems not to have occurred.

The same relations hold good to some extent north of the river, as in Newry and Andover in the low lands bordering the streams. Parts of those towns are mountainous, however, and those portions except where they have been burnt over, have a liberal mixture of spruce. Weld is another rough town from which the spruce has been mainly killed out by clearing and fire. But the line of division in general is pretty clearly marked. Riley is about all mountainous, and is a heavily spruced country on which much of the original growth remains. Grafton, Andover North Surplus, Letters D and E and No. 6, no one on seeing could have any doubt about. They are mountainous in the extreme, and those mountain slopes, except where burnt or cut, are heavily and evenly covered with spruce.

These townships that I have referred to form a barrier separating the upper from the lower course of the Androscoggin. To the south is the lower river flowing approximately east for fifty miles, catching streams from both sides of its course. To the north of that barrier lies the Rangeley lake system, again with its axis east and west, and about thirty miles in length. The lakes, therefore, situated as they are close under this mountain barrier, receive only trifling tributaries from the south. Their volume is chiefly maintained from the country to the north which drains into them by three considerable streams, the Magalloway, the Cupsuptuc and the Kennebago. The outlet of the system is at the west, where the river forces a way for itself close under the eastern face of the White mountains. At the east on the other hand the upper lakes are closely approached, on high but elevated land, by the head waters of the Dead and Sandy rivers, which run into the Kennebec.

Now as the Rangeley lakes, with the exception of Umbagog, are about 1,400 feet above the sea, while the country about is, much of it, considerably higher, this upper Androscoggin country is more elevated than any other area of equal size within the limits of the State.

Finest spruce in Maine.

Here then on the headwaters of the Androscoggin is the chosen home of spruce. Continuous with the high land of northern New Hampshire, a part of the great White Mountain plateau, this region in its elevation, its uneven topography, and its climate seems to afford that combination of conditions which ministers to the perfect development of this species. The timber of the Appalachian mountains further south is not known to the writer. No other part of Maine, however, ever had any such spruce stand, and probably no portion of New York or New England as is found from here across northern New Hampshire. Only patches of timber elsewhere stand as thick as does the country here. The timber too is much of it of the finest quality and size.

Cutting history.

A paragraph in general regarding the cutting on this drainage will be of service before starting in on its detail examination. Brunswick was the center of the early lumber business on the Androscoggin, and much of the early pine cut was sawed there. It was after 1850 that the bulk of the business was shifted up river. About 1852 mills were built at Lewiston, while at the same time the Grand Trunk extended to Berlin, N. H., and mills were located on the falls at that point. In 1852 also dams were built on the lakes, and drives from the lake region, which up to that time had been small and uncertain, became regular and considerable in amount. But all this early lumber was pine. Pine was originally on almost all the drainage mixed with the spruce. Spruce, however, through all this upper region was always the most abundant coniferous timber.

It is only within forty years that spruce has been cut on the Androscoggin, while from as far up as the lakes no spruce was driven out till the first years of the war. The length and difficulty of the drive has saved the timber, and kept the river much behind the Kennebec in the utilization of its lumber resources.

To understand the course of the spruce cut, another glance at the map is necessary. This will show that the middle course of the Androscoggin—which is its lower course in the spruce belt—is within the limits of the state of New Hampshire. Much of the cutting up to the present time, therefore, has been on the New Hampshire side of the line. That portion of the Androscoggin drainage is indeed comparatively severely used, and hard cutting has extended about up to

Parmacheenee lake on the Magalloway river. About the Rangeley lakes light cutting has been going on over accessible lands all the way along for thirty years. The Cupsuptuc and Kennebago, saved by the length and difficulty of the drive, have never been seriously cut into, and are now practically in their primeval condition. South of the lakes, too, considerable country is in the same shape. The Bear, Ellis and Swift rivers are small and quickly falling streams, which it is scarcely possible in their upper portions to drive. The territory about their head waters, therefore, is virgin land, a part of which, on the advent of railway facilities, is just now beginning to be utilized.

It thus appears that about half the Androscoggin spruce country is in its original condition, while a considerable portion of the remainder has been very lightly used. In proportion to its area the Androscoggin drainage is the most valuable spruce land in the State. Its provident treatment, meaning by that both the economical use of its natural resources and its conservation as a timber producing country, may well be one of the prime objects of public forestry in this State.

Scope of this study.

In a month's cruising in the Androscoggin spruce lands no man could cover the entire territory, or see as much as could be desired of its timber. Certain things it was necessary to do, while others had to be left undone or the facts taken at second hand.

As to the stand of merchantable timber, there was little cause to worry. I was particularly fortunate in securing the voluntary cooperation of Mr. J. A. Pike of Berlin, the man who more than any other was qualified to furnish reliable information on that matter. A man of sound judgment and conservative temper, Mr. Pike has had the best of opportunities for their exercise. For twenty years he has been an explorer and surveyer on the Androscoggin. Probably half its townships he has looked over carefully himself, while as to many of the others he has access to the most reliable information. His judgment on timber has been tested in all kinds of circumstances, and checked many times by the actual cut. More Androscoggin timberland has been bought and sold on his judgment than on that of any other man. Mr. Pike's figures, therefore, must be considered as the best obtainable, and as trustworthy within narrow limits. They will be found in their proper place in this report.

Certain things had to be done, however, to make any such survey of the Androscoggin as had already been carried out on the Kennebec. One thing necessary was to map the burnt lands, and so with the water areas to throw out from the total acreage the proportion that is not producing spruce. It was next necessary to go over enough of the cut-over country to see in what shape the different companies leave their land, how badly it blows down and what shape it is left in to grow. The rate of growth of cut-over land had next to be studied, for which purpose the old lake cuttings of twenty years or more ago furnished the best opportunity. Lastly it was necessary to go to the virgin timberland for the determination of some facts which have a most important bearing on the manner of its treatment. These were the purposes which directed my travel and observation.

Grafton & Riley.

Starting in at Berlin, N. H., and loading up with local information from my friend, Mr. Pike, the first start into the woods was into the neighboring lumber operation on Riley, Grafton and Success. A logging railroad built from Berlin out into the district named had opened up a rich spruce country, in which cutting had been going on summer and winter for the last three years. Riding out to the camps and starting in to look around, the heavy stand of spruce was soon evident. As with all timber countries, there was considerable variation in the stand—far less, however, than would likely have been the case in central or eastern Maine. Of mountain land there was enough certainly,—to the east lay the range formed by Speckle mountain, Mahoosuc and Gooseye, of which Speckle comes near to being the second highest in the State—but these were well timbered high up on their sides, while under the lumbering methods practiced, little, except the bare ledges, was waste. To the left again, lay a swamp area of considerable extent, but this was not without its timber, while all intermediate land was covered with a heavy mixed growth in which was a strong mixture of spruce. Much of the timber, too, was of the finest to be found. Good drainage and sufficient soil are the almost uniform attendants of these rough lands, and except well up in the mountains the spruce in this region gains its largest size and finest quality.

Genuine clean cutting.

The cutting here practiced was of especial interest. Most lumbermen say that in an ordinary chance, with any distance whatever to haul, trees less than ten or twelve inches at the butt are not worth handling. Neither would the average lumberman go 1,500 feet in vertical height up a mountain side for the little stunted spruce found on such places. Owning the land himself and charging himself no stumpage whatever, merely the difficulties of lumbering would stop him from so doing. He would say it didn't pay, that that timber under present conditions of business was out of reach for human use. Not so here however. Berlin, consuming in its different mills a hundred millions of spruce per year, provides a market for logs of all sizes and grades. The thick stand, and the evenness of it, requiring that roads be put in thickly and everywhere, induces the closest cutting, while organizing ability of the first order overmatches the hardest natural obstacles, and brings to market at a profit a quality of timber which for ordinary operators to handle would be financially ruinous. Carloads of logs have been hauled into Berlin which ran as high as forty sticks to the thousand.

But we must see in what shape cutting leaves the land here. If this report, like some publications on the subject of forestry, were a picture book, and the selector of choice landscapes had by any evil chance got as far as ten miles away from commodious cars and a soft bed, this volume would no doubt have been adorned with several views from this locality. It is the hardest cutting ever seen by the writer outside of a woodlot. When the operation was first started, cord wood was cut as well as lumber, and here the surface of the ground was an almost unbroken brush-heap, out of which there stood erect only the few crooked and scrawny yellow birches which were not worth the dynamite that would have been required to split them. Plenty of ground that started with fifty hadn't more than two or three cords of wood of any kind standing upon it.

Future of this land.

Cruising round in the newer works, it was evident that so far as spruce was concerned quite as complete devastation had been wrought. The hard woods had here been left, but the future prospects of the land perhaps were even worse on that account, for the hard woods left standing, which now at any rate are undesirable and valueless species, will be sure, as many times seen in old cuttings elsewhere, to spread out their crowns and largely appropriate the ground. They are in position too to shower the ground with seed, and so put competing species at a disadvantage. A hundred years will not suffice to grow another crop of spruce logs on that ground, and at two hundred it could not fail under the circumstances to be much smaller than the original stand. I agree with the owners of the land in thinking that if fire could be controlled the best thing to do for this country would be to burn it clean, and take the chances on an entirely new crop.

Amount of spruce left.

Some determinations of the spruce left on this land will be of interest. Considerable territory was cruised, and selecting two or three pieces of representative ground a count was carried for more than a mile and a half across the works of all spruce trees big enough to show above the brush piles. So far as seeing was concerned, one might sometimes have counted for a quarter of a mile each way. My strip, however, in order closely to estimate it, was confined as usual to a width of about forty-eight steps, or the side of a quarter of an acre. Proceeding thus, the count for 3,900 steps, covering an area of about twenty acres, gave me the trees recorded in the accompanying table. Of these the larger were often forked, crooked or otherwise deformed. But few trees above six inches had been left intentionally. Trees down to seven inches at four feet from the

Diam.	No.
2 in.	22
3 "	46
4 "	47
5 "	32
6 "	20
7 "	6
8 "	6
9 "	4
over 9	10
Total.	193

ground had been regularly cut to haul away, and smaller ones if they were in the roads. Many too of the smallest sizes were smashed down, as is evident from the small number found standing. Altogether the count gives me between nine and ten spruce trees per acre, about thirty cubic feet, which as near as I can tell is about one per cent of the original stand.

What species form the next growth—their value.

What now is coming up on that land to replace the timber cut off? In the first place it will bear repetition that the ground will not be altogether left to a new crop, but will be largely occupied by the trees left in cutting, the undesirable ones in species and quality, which will spread out and largely cover the ground. As to the new growth, it is certain that it will not be mainly spruce. White birch, I think, is the tree that will be most prominent in the new growth. On this ground and in other places where hard spruce cutting had left the ground nearly bare, the prominence of this species was many times noted. On old yards and sluice-ways it is apt to be especially abundant. And this is what would be expected from the biological characteristics of the tree. It requires a great deal of light, and so, while it is not abundant in the virgin forest, it does spring up freely on burnt or abandoned land, being aided in its diffusion by the extreme lightness of its seeds. Heavy cutting or a blow-down again afford the necessary conditions for its growth, and here too it is abundantly found.

Not uniformly or alone however. Dwarf maples, *Acer pennsylvanicum* and *A. spicatum*, are very apt to fill up gaps caused by cutting. Cherry is another tree that shows a similar propensity. Twenty or thirty years, however, is about as long as these will last. They die out finally, crowded out by the longer-lived trees, yellow birch and maples, which are almost always mixed with them.

Evergreen trees moreover are not absent. Small fir is one of those things that is almost sure to be seen whenever in the woods one looks about him. There is generally a lot of it on

Relative persistence of spruce and fir.

the floor of the virgin forest, and when the overgrowth is cut it still persists and sends its leaders up through the brush and tops. A new growth of it may start too. And it is especially noteworthy that mixed with it in both cases there is almost sure to be a proportion of spruce. This may be numerically small, but potentially it is quite otherwise. Fir, we all know, is a short-lived tree which only in very favorable circumstances reaches a merchantable size. Spruce on the other hand is long-lived and persistent. Its infant mortality must be small. Its presence on a piece of ground is sure to mean something.

Spruce and white birch.

Perhaps the most valuable combination possible is white birch with spruce. This on old yards and sluice-ways was seen not infrequently. A thick mat of birches, perhaps mixed with other species, covered the ground, running at say three years of age from two to three feet high. Among these was a generous sprinkling of spruces of the same age but only six to eight inches high. Now the future of such growth is not uncertain. The birch will bring a crop to maturity in fifty or sixty years, a crop that if spread extensively over the country would be not greatly inferior in value to its predecessor. At that time, however, the young spruce will not have reached even pulp log size. To do this in thick growths which alone produce much material on the land —that is to grow logs ten to twelve inches through at four feet from the ground—at least one hundred years will be required. Observations on this point are recorded in another portion of this report.

To return to the land immediately in question—mixed growth I will repeat from which the spruce has been cleanly cut, the spruce having formed so large a proportion of the original stand that the land is now in very ragged shape,—the new growth springing up is quite prominently white birch. With this are other hard woods, prominently some of dwarf size and short life which have little bearing either helpful or harmful on the future of the land. The cleaner the cut, the larger the ratio according to my observation that the birch bears to the other species. In places a good deal of fir and spruce is springing up. The latter seldom makes any great showing on the ground at present, but given sufficient time it may be counted on to regain a fraction of its old standing in the cover of the land.

What shall we think of it?

Here is one way to treat timberland, and much as it has been clamored against, there is something* to be said for it. At any rate the men who lumber in this way are not to be indiscriminately howled at. They are keen business men, endeavoring through the purchase of land and the cutting and marketing of its timber, to build up a fortune for themselves and their heirs. Every stick of timber standing on their land that can be cut and marketed at a profit, they cut and sell, and invest the proceeds in more land and a bigger operation. And as business men of the sharpest kind, taking into account, too, the facts of growth and the future of the market so far as they are known or can be judged, there is little doubt that their decision is financially sound. If they were mill men primarily, with a big capital invested in plant and a vital interest in its permanent supply, they would look at the matter differently. Were they investors of money looking for a moderate assured return on capital invested, their cut would doubtless have much more reference to the steady output of spruce from their land. If they were not logging by rail, but driveable streams kept an outlet for logs continually open without expense, even that might determine them to leave the young timber to grow, with the purpose of cutting over the land again in twenty or thirty years. Neither of these things is the case, however, and as things stand, their judgment is not at fault. Every dollar that they can make will bring in more invested in their business than the growth of timberland will pay. They do what every other business man would do in the same circumstances if he were as strong in his purposes and as sharp in his calculations. Under these circumstances I submit that complaint about the rapacity of lumbermen is both futile and foolish. If the State's interest is different from that of private owners, then let the State in some efficient and business-like way look after it.

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*Perhaps the reader wonders what that "something" is. It lies just here—in the complete utilization of the original stand of timber. There are here none of those great wastes through slack methods, blowdown of timber left, etc., that were so often noted in our earlier study.

But is the State's interest different from that of private owners? After much field study bearing directly on this point, and considerable thinking over the questions involved, I for one am not entirely clear on that point. There are balanced and complicated considerations here, a multitude of circumstances and possibilities coming in from every direction which render a decision very difficult. The rapidity of growth and the requirements of different trees, the risk of fire and insects and the liability of thinned growth to blowdowns, the future of the market in regard to different kinds of woods, dependent as that is on the discoveries of science, the development of business, and the amount and accessibility of the world's supplies—all these affect the question materially. To reckon in such circumstances is not within the limits of possibility. A lump judgment, fallible as that must be, is the only open course.

TREES STANDING ON AN ACRE OF LAND IN GRAFTON, OXFORD COUNTY, MAINE.

Diameter—inches.	SPRUCE.				OTHER SPECIES.						
	Number.	Height—feet.	Volume—cubic feet.	Estimated scale.	Fir.	Hemlock.	Yellow Birch.	Beech.	Maple.	Estimated volume—cubic feet.	Estimated scale.
Over 18	6	75-85	500	1,800	–	3	4	–	–	430	
15-18	24	65-80	1,200	4,200	–	3	–	2	1	250	
12-14.....	10	60-70	290	1,160	–	6	6	1	1	350	
10 and 11	12	55-65	225	837	–	–	2	12	2	240	
8 and 9	24	40-55	265	795	3	6	5	14	2	270	
6 and 7	21	35-50	120	–	2	–	7	12	2	135	
3-6	63	-40	125	–	10	10	42	25	–	170	
Under 3	366	–	35	–	105	30	20	16	4	15	
	526	–	2,760	8,792	120	58	86	82	12	1,860	2,000

This study, however, has to do only with those factors of the problem which can be studied in the Androscoggin woods. In order to get some more facts of that nature before our view, let me, after presenting the notes of a sample acre of virgin land at this point, conduct the reader to some new territory.

As to the scale put on these trees it should be said that for the hard wood and the large spruce (those above fourteen inches diameter) the figure was set at what it was judged the trees would yield as ordinarily cut and scaled in the locality. A reasonable discount for imperfections has to be made. In regard to the small trees it was necessary for the calculations to be made later that they should agree relatively. A method of conversion from cubic feet into board feet had therefore to be devised, as true as might be to the usual or the best practice.

The same is here used as was used in the case of the Kennebec. This supposes the Maine log rule to be employed in scaling and not the Blodgett or New Hampshire rule which, however, is now somewhat extensively employed on the Androscoggin this side of the line. For the principles of this method of conversion see page 50 and also the discussion of scaling in the third section of this report.

The Blodgett rule gives a larger scale on small logs than does the Maine rule. The ratio between cubic feet standard measure and board feet as read off from the rule is in fact nearly constant in logs of all sizes. This would affect the percentage rates of increase as worked out in the following discussion, in most cases to depress them to a slight extent. The calculation has been worked through on the basis of values given by the Blodgett rule, but for clearness' sake it is thought best not to publish results.

EXPLORATION ON THE MAGALLOWAY.

On Friday the eleventh day of October, at Cambridge, N. H., I met by appointment Mr. John C. West of Berlin, a trusted explorer for the Berlin Mills Company and others, whose local knowledge and experience in estimating I was anxious to profit by. Procuring a leaky sail boat at Cambridge, we made the most of a stiff breeze up Umbagog lake, and tramped through the woods from the head of the lake to the Brown farm on the Magalloway river. Next day, hiring a canoe at Aziscohos, we paddled twelve miles up the river and in mid-afternoon in a cold drizzle reached the Parmacheenee Club's "Camp in the Meadows." Here we were in the middle of "Parkertown," or V Range III, and engaging board for a few days we made the camp our base for a partial exploration of the township. This township was selected for exploration, not only because its owners are among the largest owners and operators of timberland in the region, but because the woods superintendent of the company, a close student of woods and mill economy. had recently inaugurated some improvements in cutting, and I was desirous, by looking the land over and talking with the operators and men, to see how the changes worked.

The Magalloway. Topography and timber.

The Magalloway country has been and still is a great spruce preserve. Above Aziscohos falls its course is nearly parallel with the State line and from two to three miles distant. Five townships in the northwest corner of the State thus have the Magalloway flowing down their middle, an arrangement which, except in the most northerly of the five, avails to make their timber completely and readily accessible. This basin is bounded on the east by a high, rough ridge, broken with one or two mountain peaks, which follows very nearly the east line of the towns. On the west, similar land separates it from the Diamond and the Connecticut. An area of about two hundred square miles is thus enclosed, exclusive of the country below Lincoln Plantation. This country was naturally heavily timbered and for spruce but little of it was waste land. The water areas by the maps foot up about seven square miles. Of burnt land there is, as near as I could learn, about five. Of waste in mountain top and bog there was to be seen but little. Perhaps all items may foot up in land which is not producing spruce ten per cent. of the whole.

Parkertown is perhaps the most typical township of the five. The river flows through its midst, winding back and forth in a belt of alluvial land. Into the river from each side run a number of brooks. These reach back to the divides, and since they are themselves separated by high land, the town is divided into six or eight different basins, each of which is, for purposes of lumbering, a district by itself. Outside of the flat land along the river the country is uneven, much of it pretty rough. Drainage therefore is excellent and while there is seldom much of any soil, there is amply sufficient for the production of spruce. The mountains were covered with it nearly pure; the ridge country had mixed growth in which spruce almost always bore a strong proportion; the alluvial land along the river and the small areas of flat land on the brooks have generally a considerable mixture. In the virgin condition of the township acres without their two or three thousand of spruce must have been infrequent, while the average stand would have been considerably greater.

Exploration—methods of observation.

This particular township, however, is now largely cut through. The day after our arrival bringing weather in which woodsmen feel called on to be up and doing, we left camp in the morning and struck east by the compass to see what we could find. A few rods travel carrying us out of the alluvial land, we struck next a ridge country in which spruce formed originally about half the growth, mixed with fir, yellow birch and some white birch and maple. The land was cut ten years ago, not as closely as in work of more recent years. Travelling long enough to get an idea of the country,—the lay of the land, the nature of the original growth, its thriftiness and the character of the cut—my companion and I started together our systems of count and estimate on which was to be based a judgment of the growing capacity of the land. West's purpose in estimating had always been chiefly to ascertain the amount of merchantable timber on the ground. He counted trees therefore that were of size to cut, setting his limit at the lowest notch, and estimated their contents in board feet. His practice, moreover, was to count over a circle of seven rods radius around him. My idea, on the other hand, was to get at the growing power of the land, and my count stopped with six inch trees only because the smaller sizes could not be taken in with accuracy. My examination of the ground, moreover, was to one side and to the width of a quarter of an acre. Our practice was to count this way for half a mile, distance being determined by count of steps, and then compare notes, talk over what we had seen and pursue on the spot any suggestions received. Then we would travel on further, looking the country over more at liberty, studying the young growth coming up in the gaps, and comparing our observations and experiences in general. During the course of our ten days together I learnt a great deal from Mr. West, and I have always thought that the general agreement of our estimates spoke well for the work of both of us.

Amount of spruce left in cutting.

As was said earlier, the first ground we got into was covered with mixed growth cut out ten years before, yielding a large cut of spruce. The hard woods on the ground, however, had been plenty enough to keep the stuff left from blowing down much. As for the amount of spruce standing, West's count for the first half mile averaged eighteen trees and 1,300 board feet per acre. My count took in thirty-four trees six inches in diameter or over per acre, and set their contents at 525 cubic feet. The stand of all species was set at something like 1,200 cubic feet.

Where timber blows down.

Passing soon over the ridge into the basin of Lincoln brook, a territory of heavier hard wood was entered which probably never possessed more than three or four thousand feet of spruce per acre. The spruce now standing after a cut six years old stood in a similar small proportion. A short distance through this brought us to a piece of rough ledgy country which offered no firm rooting to trees, while in the original condition it was covered with nearly pure spruce. The cut, therefore, had left the land very ragged, and especially subject to winds. A detailed count here yielded West about 700 board feet per acre, while by my count there appeared to be standing twenty-six trees whose contents was set at 275 cubic feet. The stand of all species was perhaps 400 or 500 cubic feet, while a much larger amount of wood lay flat on the ground. After that we came into well mixed growth standing like that first described. Here we took occasion to cut down a couple of trees for detail measurement and to test in quite a number the percentage of growth characteristic of this typical, thinned-out land.

A thick ring. Its cause?

A little matter that came to our notice here is worthy of mention. The writer was doing the measuring and taking notes, while West made the shoal cut necessary and counting in marked the tenth ring from the bark. Now having his attention directed particularly to this ring, he soon noticed that it was thicker than its neighbors to a very perceptible degree. He found, in fact, that he could by this mark put his pencil on the tenth ring without counting, and that in almost every tree. The same thing I believe I had previously noted in Grafton, though it is not down in my note book. We afterwards found it, however, at Bemis, and about the Richardson lakes.

This little fact is one of those suggestive things which sets everybody to theorizing, but which to carefully follow out is a very different matter. A thick ring, let me say, found regularly and over a considerable extent of country is somewhat of a novelty, at least to the present writer. Thin rings are not infrequent, constant or nearly so in their position, and found throughout a large range. Often they are known to be due to cold and inclement seasons. For this other occurrence, however, I have not yet discovered either a parallel or a cause.

Where good roads pay.

About Lincoln pond in the northeast part of the town is a considerable body of virgin timber. This of course cannot be hauled to the river at its nearest point, but must go down the brook through which the pond discharges. This was a four mile haul and as a good many millions of timber had to go that route, a good road was the first thing in order. This we crossed on our easterly course, finding it the best ever seen by us in the country, cut out wide and carefully graded before freezing. Probably when the hauling is good, five thousand feet of lumber will go down it at a load.

Passing the road and the brook nearby, old works were again found in growth like that first entered, but more recently cut. Turning south, count for half a mile gave West twelve merchantable spruce trees to the acre, footing up about 1,000 feet. My count yielded twice the number with a total stand of 400 cubic feet. This timber, readers will understand, has not grown since the cut. A spruce tree six years old could hardly be much over a foot high. The trees classed as merchantable in the count were mostly between eight and eleven inches in diameter four feet from the ground which when the cut was made may have been an inch smaller. They were trees which partly from their small size and partly from their scattered position were skipped in the cut. The original stand from which they were left probably stood five or six thousand per acre of spruce, or an equivalent of 2,000 cubic feet.

New growth after cutting.

After travelling south for a mile or more, a turn to the west was made. This course finally brought us to the river, up which the drivers' path carried us to camp. On the way a sample of the alluvial land was seen, while a little burnt area was passed, and its extent approximately ascertained. When we got in we compared notes finally on what we had seen relative to young growth coming up in the cuttings. On half the land seen we agreed that young fir mixed with spruce was the most abundant growth. On the remainder, mixed hard woods, in which at present dwarf maples are most prominent, hold the ground. The two things were mixed largely, but in general this proportion was thought to hold. The significance of these different elements, their permanence and prospective value, has already been indicated.

The reader of course cannot be burdened with a mass of this kind of detail. It has seemed well, however, to explain and illustrate the methods of inquiry used. If these are approved of, if the methods devised appear to be adapted and sufficient for the purpose, a presumption will be created that they were used with good judgment and discrimination. As to the amount of timber left and consequent inferences as to the growing power of the land, little more than the final statement of conclusions remains to be said.

Where cutting should be unsparing.

There were, however, some special objects connected with the exploration of this town. Striking out on Monday morning to the west, the valley opposite camp was traversed, then we struck over the ridge into the basin of the next brook north. On the divide was found what is not so infrequently seen on high ground, a piece of flat wet land, in character approaching bog. The ledgy ridge crown was flat and almost devoid of mineral soil. Vegetable material, however, moss and decayed leaves, formed a stratum from which there had grown up a heavy stand of spruce. The cut here had been heavy, but it might well have been heavier, for most of what was left had blown down.

Ledgy land, where the trees simply sit on the surface and are not anchored into soil, can be treated in one of only two ways, if its value is to be reaped. Either but few of the trees should be cut, the largest and tallest, leaving enough for mutual protection from the winds, or else every stick that can be handled at a profit should be taken. Half way measures are most wasteful. The winds of our ordinary seasons will destroy in five years after opening such timber more than will be replaced by the growth of the next fifty. The practical thing to do, when it is determined to touch such timber at all, is to cut it clean.

Sawing down timber.

This is the first locality where I ever saw spruce sawed down. At this particular point the logging was done by jobbers, but under close inspection by the owners of the land and mills. Stumps were cut from a foot to eighteen inches high, in most cases down to the flare of the roots, and there certainly did appear to be a saving of timber. Saving in cost and time is a different matter. Operators so far as talked with gave the method a bad name, while the representatives of the owners of the land thought it had worked well, and that the inevitable objection to change was being gradually overcome. At any rate they required it of their own men. There seems to be a difference on this point between small and large timber. In the pineries about Rice Lake, Wisconsin, as I learned on a visit there, sawing down was introduced because it saved in time, not for its economy of timber. In the comparatively small timber of our own State the facts may be different. Sawing down involves more tools to carry and more clearing away and fussing round before men actually get to work on a tree. Altogether there seems to be an economy in the use of the new method in our own woods.

Use of knotty top logs.

In this connection another feature of the cutting all about Berlin should receive attention. This is the way in which logs are run up into the limbs. Berlin is very economical in its use of timber. There is no waste from its mills unused. On all the tributary country logs are cut very long. Big trees scaling 200 to 400 feet are run up to seven or eight inches at the top; small trees are cut off at four to six. The knotty tops are some of them sawed into scantling. Many also go into pulp, sawed up into lengths for the barker and only the largest knots split out. It is newspaper material mainly that is made at Berlin. For finer grades of paper that quality of wood could not be used. At any rate most pulp mills in Maine, and the saw mills too for that matter, have their timber topped off at the lower limbs, wasting in this way from fifteen to twenty per cent. of their available lumber.* About the first step, it would seem, in the preservation of our forests should be the securing of greater economy in the use of their products. The waste mentioned is the more unjustifiable because it is very largely due to our faulty and unjust methods of scaling timber. A discussion of this matter will be found elsewhere in this report.

Leaving small timber to grow.

The most interesting topic of inquiry pursued on Parkertown was a system of cutting inaugurated within two years, designed to save the small timber for growth. The woods work of the owners of Parkertown is very carefully looked after, and the superintendent of the company, backed up by his chief assistant, having regard for the future of the land, had hit on the scheme of leaving trees twelve inches and under on the stump. It was stipulated in contracts with jobbers that trees of less size should be left unless they stood in the line of the roads, while the same rule of cutting was impressed on the minds of the company's own men. I wanted to see how the scheme had worked, how the men viewed the new regulation and what effect it had had on the growing power of the land.

There was but one criticism on the scheme that I had to make *a priori*, and the justice of that was readily assented to by its author. A stump diameter is a very variable and unsatisfactory measure. A standard of ten inches diameter four feet from the ground would accomplish about what was desired, and be a much more reliable and handy rule. Other considerations suggested were of a more fundamental character, not urged with a view to their immediate adoption, but rather formulated for consideration during the study of the land. A practical woodsman, of course, had not to be reminded that in many places it was of no use to leave small timber, that such as he did leave would be almost sure to blow down. In another way, however, the plan seemed inadequate to accomplish its purpose. The course determined on, while it is a step in the right direction, seems not to go far enough. Not enough is left to make the succeeding growth of much account. In a good growth of virgin timber the trees between ten inches in diameter four feet up and the smallest size that would anywhere be cut are not many in number or large in volume. Little is sacrificed and little gained by leaving them standing. If a man really means to cut for future growth, he should, in virgin land at least, leave more on the ground.

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*See appendix for figures bearing on this point.

This was the view taken off-hand. At the time, as was said, it was only stated tentatively and for consideration. The point was held in mind throughout my exploration, and it will be again referred to in the detailed discussion further on.

How it works.

As to the results of the scheme in practice, however, I could not see that it had yet made any difference in the way the land was cut. This was due not so much to defects in the plan as to the men who had to carry it out. The old habit of cutting everything they came to, leaving only such trees as were off by themselves and therefore required extra effort to get, was too strong to be overcome in a year. The men didn't appreciate the purpose of the regulation, and unless constantly reminded, would pay it no attention. The man in charge of one camp, I found, didn't remember how his contract read on that point,—ten or twelve inches at the stump, he wasn't sure which, was the limit set. Certainly that man was not efficiently carrying out a well planned forest policy. Among the sawyers, there was a corresponding indefiniteness and laxity. No noticeable effect on the cut could indeed be seen. When timber that this far from the mill could be considered merchantable had been left, it seemed to be left because it was hard to get at.

The same thing was true in the work of the company's own men. In my note book I find record of one spot where at the end of a twitch road four stumps, 12, 11, 11, and 10 inches in diameter were found. Twenty feet down the road was another thirteen inches in diameter and two more below about the same distance apart. These seven trees were what the road was cut for. At the end of it was the little bunch of four, and when the men came to it they cut it, though under size. Now if land is to be cut with a view to growth, it is just such trees as this that should be left standing.

Difficulties to be met.

What is here said is not said from an unfriendly or discouraging attitude. Every attempt to manage land with a view to the future should be aided to the fullest degree by the State. But attempts of this kind should not be made blindly, unmindful of the real difficulties that lie in the way. What is here said will call attention to the fact that when a saving cutting policy is determined on in the office of a big lumber company, that is not the end and execution of the matter. The axemen and men in charge have still to be considered. Their wasteful habits must be checked, their old methods so far as they conflict with the new policy corrected. And this is not the work of a day. It will take time and the sharpest kind of superintendence to effect it.

Let it be clearly understood that before any great saving can be effected in our lumbering, new methods must to a certain extent be developed, and men trained from the top down. The training up of a professional class of head men and choppers is especially desirable, men who shall chose trees and protect young growth to as good effect as they now plan their roads and the felling of their timber. This is a long labor, one in which the experience of other countries can help some, but not much. The brunt of it must come in our own woods. With all genuine efforts in this direction, the co-operation of State forest commissions should be of the heartiest.

Sample acre —important inference therefrom.

Returning again to Parkertown, let me present some figures that will be used in the further discussion of the problems arising in connection with the management of these Androscoggin lands. First, is a detailed statement of the trees standing on a sample acre that, fairly representative of the country in its stand of mechantable spruce timber, was thought to be approximately such also in respect to the proportion of hard and soft woods and large and small trees. Note particularly the number of large spruce trees as compared with those from six to twelve inches in diameter. Their relation is no chance or insignificant mat-

TREES STANDING ON AN ACRE OF UNCUT LAND IN TOWNSHIP 5, R. 3, OXFORD COUNTY.

	SPRUCE.					OTHER SPECIES.					
Diameter—inches.	Number.	Height—feet.	Volume—cubic feet.	Estimated scale.	Diameter—inches.	Yellow birch.	Beech.	Maple.	Fir.	Estimated volume—cubic feet.	Estimated scale—feet B. M.
Over 18*...	14	70–90	1,000	3,500	Over 18....	11		1		1,000	
15–18 *	14	70–80	600	2,000	14–18	6		4		400	
12–14	9	60–75	210	840	12–14	2	2	6		200	
10 and 11*..	8	50–65	135	502	10 and 11...	4	3	8	1	300	
8 and 9.....	18	40–50	170	510	8 and 9.....	3	3	13	3	200	
6 and 7.....	6	35–45	35		6 and 7. ...	3	2	3	1	50	
3–6	32	–40	60		3–6	8	10	4	44	130	
Under 3 ...	90		10		Under 3...	4	29	1	165	20	
	191		2,220	7,352		41	49	40	214	2,300	4,000

* One worthless tree in each class.

AN ACRE OF LAND ON SAME TOWNSHIP FROM WHICH SPRUCE WAS CUT FOUR YEARS AGO.

	STANDING.				BLOWN DOWN.			
	Spruce.	Fir.	Hard wood.	Estimated volume—cubic feet.	Spruce.	Fir.	Hard wood.	Estimated volume—cubic feet.
Over 18			1	65				
14–18...............			5	200			1	60
10–14.......			10	226		1	1	45
6–10......	9	7	30	370	2	6	1	80
3–6.......... ...	7	12	8	65	1		1	5
	16	19	54	920	3	7	4	190

Very small trees not counted. Original undergrowth largely fir and spruce, which still persist. The roads are full of raspberry bushes and white birches, 1-3 feet high, among which are many fir and spruce 4–8 inch high. This acre left unusually open.

ter. Much study has shown it to be characteristic of typical Androscoggin spruce land, while from it are drawn hereafter important practical conclusions. Beside this virgin acre, are put the notes of an acre not far away from which the spruce a few years ago was very cleanly cut and which has since been visited by winds.

Amount of wood left in cutting.

As to the amount now standing on the cut-over portions of this town, it appears after getting together the notes of three and one-half days' travel which include the detail count and estimate of the growth for about five miles, that a fair figure for the spruce left after cutting on the mixed lands which certainly comprise four-fifths of its surface is 350 or 400 cubic feet. In this amount a fair allowance has been made for the small trees under six inches not included in the count. Three hundred cubic feet, however, is probably in the shape of tree six inches and over in diameter, which number about twenty to the acre. Of these enough might be considered merchantable to make up an average of 1,000 feet board measure on a close scale by the Blodgett rule. All the spruce left, as near as I can estimate it, amounts to some fifteen or twenty per cent of the original stand.

This is a hard cut, but it is characteristically a systematic cut. The even mixture of spruce made it worth while to go all over the land. The cutting was done by the owners of the land who also manufactured the lumber, or by jobbers who were under strict contract and close supervision. It is vastly different from the work that will be seen in the bunchy timber and stumpage-cut lands of the Penobscot river.

THE RANGELEY COUNTRY.

One more set of facts remains to be brought out before we shall begin to discuss the question—how should the spruce lands of the Androscoggin be used to get the most and the best out of them?

The Rumford railroad.

Up to the present time lumbering in Maine has been guided almost entirely by the water-lines. The amount of spruce logs transported by rail has been insignificant compared with the quantities that have been driven down the rivers. This state of things on the Androscoggin is soon to be changed. The new railway from Rumford north hauled its first logs into Rumford in November, 1895. Completed to Bemis in 1896, if extended to Megantic as intended it will open up, it is thought, not less than a thousand millions of spruce timber. This new movement is justified and needed. Large areas of land have so far remained uncut, with very little value except a prospective one, because of their position and the difficulty of the drive. So it has been with most of townships D, E, and 6, the barrier of mountain land which separates the lower Androscoggin from the great lakes on its upper course. So in a less degree it still is with the townships on the Cupsuptuc and Kennebago. Railroads are essential to the development of their resources, either to take the lumber to the mills or to place the mills nearer the lumber. All that country north of the immediate vicinity of the lakes is, except in respect to pine, in its primeval condition. Spruce has never been cut, and the country, so far as I could learn, has not been touched by fire.

About the Rangeley lakes.

The towns bordering the lakes have had a different history. From here, driving by river was not prohibitively expensive. The land lay, too, in shape for easy logging, with a slope generally that would help bring loads to water, but without a precipitous character.

The original spruce stand in this country can hardly have been anywhere excelled, and as the cutting upon it has seldom been either systematic or heavy there is no lack of spruce at the present time. A good idea of the country can be obtained from the lakes in a steamer or canoe. Especially is this the case if one's visit occurs as mine did in the late fall, when the hard wood leaves are off and every evergreen top shows with perfect distinctness. There is little hemlock in the country. The scattering pines are distinguished by their height or by a light and shining tint of green. The spruce tops show out dark and strong, a fit feature seemingly in the landscape of this high and rugged country.

A practical explorer learns very much about his country by these general views. The thickness of evergreen tops tells something about the amount of timber, while its distribution is very readily ascertained in this way. If not at too great a distance one can tell if land has been recently cut. In that case the cover does not present an even surface, but is ragged and one can look down into the trees and see the limbs. Lastly the distribution of waste land and the location of burns, even though they may be sixty or seventy years of age, can be in this way approximately ascertained and charted. The fine white birch which comes up most abundantly on all burnt lands in this region can be told at a distance, whether in leaf or not, from the yellow birch, beech and maples which are the staples of the original hard wood growth.

The growth about the lakes is not especially different in its nature from that already described. Everywhere, except on the old burns, there is spruce. The mountains are clothed with it nearly pure. On the slopes and ridges, it is mixed in varying proportion with hard woods. From some of the flat lands, as I learned, tremendous cuts have been taken. The ubiquity of spruce is the secret of the large average stand.

New growth after cutting.

The cut on these lands, as already stated, has been light. Striking out from any point on the lake shores, the old roads if one chooses can still be followed. They are clear enough overhead, but underneath are full of young growth, generally a mixture of birches and maples with often much dwarf maple and cherry, the last of which in cuttings over twenty years old will be found on their last legs, soon to be killed out by the longer lived species. Some young fir and spruce also is generally present, but except in the areas of mossy land with soft wood growth, it is seldom predominant. I cannot think that the young spruce on the ground is sufficient to maintain the proportion the species held in the original growth.

Early cutting was loose.

Suppose we strike into the woods from Bemis, over land cut through twenty years or more ago. Following the roads back from the water, or better striking off across country in some constant direction, the method of cutting is soon revealed. Only the largest and best was cut. The roads struck for the thickest and best of the timber, leaving untouched the regions of thinner stand. Strips are passed with scattering spruce in which no cutting was ever done; then we may come to a piece of ground a half acre in extent which was nearly cleared. It is covered now with a thick growth of hoop-pole size, through which a man has to force his way, while out of this mat rise occasional big yellow birches and the small or defective spruce which at the time and under the circumstances were not worth the taking. Of the amount of the cut the stumps on the ground tell the story. Tops and brush at the end of twenty years are all rotted out, and travel except for young growth is nearly clear. The stumps, however, persist for twice that time and by their number and size give an indication of the amount cut and original condition of the land.

Our Problem.

Here then, in these old cuttings about the lakes, is the place to find out what the results of a conservative cutting policy will be. Spruce timberland thinned out by light cutting has had twenty years to grow in. What has been the result? Railroads will soon give a market value to the small and scattering timber, not only on these lands but on the whole Androscoggin drainage. Should the small timber be cut, or will it pay better to let it stand and grow?

What method of cutting should be put on these lands to get the most out of them in the long run?

Rate of growth.

The first thing necessary to determine is the amount of growth upon individual trees. The methods used for this purpose have already been stated in connection with the report upon the Kennebec drainage, but they will bear retelling here. The real basis for this is the detail study of trees, including the count of annual rings and measurement of their thickness at different points in the trees' length. More than 300 spruce trees have been thus measured by the writer in the employ of the U. S. Forestry Division, and during the course of the season's work some fifty others, cut into shorter sections and selected in accordance with the purposes of the work in hand, have been added to the number. From this work one main result is the determination of the rate percent at which trees are growing.

A short cut to the same result, allowing more trees to be brought into view without multiplying the labor in the same ratio, is furnished by Pressler's tables. These, which are based on measurements similar to those just mentioned, give approximately, merely from the diameter of a tree 4 to 5 feet from the ground and the thickness of the outer rings at the same point, the rate per cent at which the tree is growing. Checking the use of these tables by exact measures on our own timber, they furnish us with very valuable information.

During the time spent on the Androscoggin, some 300 trees were tested for this purpose, and the percentage of their growth determined. The trees so examined ran from 7 to 13 inches in diameter, and were of all degrees of thrift. It seemed necessary for present purposes to ascertain the growth, not of thrifty trees only, but of average trees through the country, and in order to do that, I made it a practice, whenever I set out to fill a page with these notes, to take every tree of the desired sizes that was come to. The trees so studied were well scattered over the country, and they are sufficient in number, it would seem, to furnish a reliable basis for drawing general conclusions.

Diameter trees breast high—inches.	Volume—cubic feet.	Growth During Last Ten Years.		
		In diameter four feet from ground—inches.	In per cent at compound interest.	In volume each year—cubit feet.
7	5.5	.68	2.9	.15
8	8	.99	3.1	.25
9	11.5	.93	2.9	.33
10	15.5	.93	2.65	.41
11	20	1.04	2.4	.48
12	24.5	.98	2.15	.52
13	28.5	.92	1.9	.54

These tables are too instructive to let any opportunity go of pointing out the things they show. Repetition is of no account alongside the possibility of failing to drive home important principles. See how the growth mounts up, as shown in the last column, from nine to ten and eleven inches. Smaller than nine inches trees produce comparatively little, after that point much more. It was independently concluded, from observation in the woods, that it is at about that size on the average that trees in uncut land rise above suppression of neighbors and gain a full crown. Note too that the amount of growth keeps on rising as long as we have record of it. In the fifty years between nine and fourteen inches diameter, trees grow more wood than in the 150 which it took them to reach that size. Eight to ten inch trees stand to a crop of sprucelumber almost as a seed does to a field crop.

The full results of this work will be found tabulated in the appendix to this report. The upshot of it for present purposes is embraced in the little table herewith presented. This may again be condensed into the following: trees between 12 and 14 inches in diameter grow at the rate of about 2 per cent compound interest; between 10 and 12 inches they make 2 1-3 per cent; from 8 to 10 inches, about 2.8 per cent. Another very handy figure is that for diameter growth. In regard to this, we may say for short that trees from 8 to 14 inches grow in diameter about one inch in 10 years. That is one answer to the constantly recurring question—what is the growth on cut-over timberlands? *

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*Mr. Crawford on looking over the manuscript of this Androscoggin report points out that the diameter growth here given is much less than that which according to his observation is characteristic. In fact in reckoning on the growth of cut-over spruce land in his letters he figures the diameter growth at an inch in five years.

Mr. Crawford doesn't mean by this criticism to dispute my facts any more than I mean to dispute his. The question simply is which figures are representative or most nearly so. On this point we must leave the reader to judge. On the two or three pages preceding it has been clearly stated how the records which stand behind these statements were obtained. The effort was made to obtain figures representative of the country and to that end the effects of conscious and unconscious choice were guarded against by taking, when notes of this kind were being taken, every tree which came in my way.

Still I am inclined myself to think that the figures for growth here given are somewhat too small. That has been in my mind ever since the field notes were figured up and comparison made with the figures of the same nature from the Kennebec. That the Kennebec averages a much more thrifty country for spruce than the Androscoggin I cannot believe, yet from these figures it would appear so.

For further study in this direction I refer to the appendix. As affecting the representative character of the figures in this table, the following is to be said:—The figures were taken from trees standing as a rule in mixed growth—that is with a considerable proportion of hard woods which impede the growth of the spruce left to some extent. This is the usual stand of timber on the lands that I traversed. Perhaps Mr. Crawford's ideas are gained from purer spruce lands which, while not in the long run and on the average more thrifty, yet after cutting give freer room to the trees left. Another thing that tends to reduce my figures, while perhaps not to make them unrepresentative of present conditions, is the fact that it is unthrifty trees in many cases that are for that very reason left. That is the cause of their being small and so left behind. Again my figures were gathered in some cases not many years after the land had been cut. Thus the trees may not have recovered from their earlier shading and gained the thick crowns and high rate of growth which later would be characteristic. This it was thought at one time might seriously affect the results, until in fact I separated out from all my figures those against which no such objection could be urged, those namely from the old lake cuttings of twenty years and more ago. The average of these figures is substantially the same as that of the whole body.

These figures at any rate are conservative. I prefer to let them stand as they are on that understanding. Perhaps their scale should be raised somewhat for the present purpose. They certainly are not high enough to represent what might be attained under a carefully studied system of forest management. At the same time it is only right for me to say that I think Mr. Crawford's figure is too high to hold as an average in either connection.

This matter of getting *representative* figures is a very important one. For instance, to the figures for age of merchantable spruce trees given in the Maine Forest Commissioner's report for 1894, exception was taken in some cases by men who knew of facts widely varying from the statements made. They had cut spruce logs from land which they had the best of evidence to believe seventy or eighty years before was field or pasture.

Now those facts, are valuable as are all facts, but how about their representative character? In this respect it will be clear, after a moment's reflection, that they cannot by any means be held to represent the average growth of spruce in the country. In the first place such trees professedly grew up on cleared land, where from the start they had free access to light and air,—a condition by no means holding of the spruce in our great areas of timberland. Secondly they were, even for their own conditions, picked trees.

Sample area in old cuttings.

The value of these figures will be best understood, when they are applied to an area. On the second of November, on the hills south of Bemis camp, I ran out in typical mixed growth, cut through more than twenty years before, an acre that will serve as a fair sample of the country. Considerable spruce stood on the ground originally, and two regions of it had been pretty well cleaned off by the cutting. Elsewhere cutting was lighter, and some trees of log size and quality were, as will be seen in the score of trees, left standing. Between twenty-five and thirty spruce stumps could be counted, indicating a cut of probably six thousand feet of lumber. Enough of the old tops could still be seen to show that the logs were topped off generally at from nine to twelve inches diameter.

TREES STANDING UPON AN ACRE OF LAND IN TOWNSHIP 3 R. 1, OXFORD COUNTY. LAND CUT THROUGH TWENTY-FOUR YEARS AGO.

Diameter—inches.	SPRUCE.			Diameter—inches.	OTHER SPECIES.			
	Number.	Volume—cubic feet.	Estimated scale.		Yellow birch.	Maple.	Fir.	Estimated volume—cubic feet.
19	1	50	170	Over 18	13			1,100
17	3	140	500	14–18	6	2		350
16	6	265	1,126	10–14	12			300
15	5	200	850	6–10	6	2	36	300
14	8	240	936	3–6	5	3	135	250
13	6	150	600	Under 3				
12	11	265	1,033		42	7	171	2,300
11	8	150	570					
10	5	60	219					
9	5	45	148					
8	8	65	175					
7	2	10						
6	3	10						
3–6	25	50						
Under 3								
	96	1,700	6,387					

Trees of smallest size were not counted on this area, nor those of the young second growth in the open places. The latter were mainly dwarf maples and yellow birch, with a small mixture of fir and spruce.

Twenty years growth following a cut.

Now confining the attention to the spruce, and of these to such trees only as are between six and sixteen inches in diameter, the problem is to find how much of their volume has grown in the last twenty years. Remembering first the rule just established relating to diameter growth, we may in the first place say that twenty years ago all trees were on the average (this applies best to those now between ten and fourteen inches) two inches less in diameter. With this figure and the use of Pressler's tables, or by employing compound interest tables with the several rates per cent which were determined earlier, the volume of the trees at the beginning of the period can be ascertained. The details of this calculation need not be here given. The little tabulation presented herewith gives the diameter, volume and scale of the trees then and now. As to scale the same rules were used as earlier. Scaled by the Maine rule, the larger a tree is, the better scale comparatively it gets. Trees eight inches and over at four feet from the ground are considered merchantable.

Number trees.	DIAMETER—INCHES.		VOLUME—CUBIC FEET.		SCALE.	
	Now.	20 years ago.	Now.	20 years ago.	Now.	20 years ago.
6........	16	14+	265	200	1,126	830
5........	15	13+	200	144	850	576
8........	14	12	240	166	996	647
6	13	11	150	100	600	380
11........	12	10	265	167	1,033	610
8.......	11	9	150	90	570	297
5	10	8	60	34	219	92
5........	9	7+	45	25	148	25
8........	8	65	65	36	175	
2........	7	-	10			
3........	6	-	10			
67........			1,460	962	5,717	3,457

Increase per year—cubic feet, 25; rate at compound interest, 2.1%.

Increase per year—feet board measure, 113; rate at compound interest, 2.6%.

The upshot of this calculation is summarized in few words. Could this acre of land have been staked out twenty years ago, after the cut, about sixty-two spruce trees * six inches and over in diameter would have been found standing upon it, containing a total volume of about 960 feet. In twenty years these trees have added fifty-two per cent to their volume and five more trees have passed the six inch limit. A yearly increase of twenty-five cubic feet per year has been made, and a gain in volume at compound interest of 2.1 per cent. Similar reckoning with the merchantable timber, putting the limit at the lowest notch, shows a yearly gain of 113 board feet, or a rate of 2.6 per cent.

PROBLEM OF BEST MANAGEMENT.

In what immediately precedes one more step has been taken in ascertaining the growth upon our culled-out spruce land. We have been gaining at the same time light on the problems that surround the question of the best system of management. We are now ready to go back to the sample acres of virgin growth that were studied, to suppose them to be cut with different degrees of severity, and to study the subsequent growth. Let us take first the acre upon Parkertown, the trees on which were recently scheduled.

Right to cut old trees.

In the estimated scale put upon that sample acre—about 7,400 feet—5,500, or three-quarters of the whole was in the shape of trees over fourteen inches in diameter four feet from the ground. That is a fact to be distinctly marked. Three-quarters of the total spruce in the natural stand of the country is mature, ready in the natural course of things to be cut. This is not merely the lumber-

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* The four trees over sixteen inches in diameter are left out of the calculation. It is an accident and not by design that they are standing.

man's interest. It is the State's interest.* In timber like this, growth is balanced by decay. Dead trees stand scattered throughout it. Upon this very acre there was one, several more were dying or imperfect, while several doubtless of the twenty-eight full grown trees scored are every year decreasing in their value. These large old trees too cumber the ground. Producing litttle themselves, they yet by their shading keep down the young growth which could make good use of the room. No one can dispute the lumberman's right or interest in regard to these trees. It is only the small timber, a quarter of the total stand, that we have to take into consideration. Let us have this material directly before us, disregarding again for clearness' sake the trees below six inches in diameter.

SMALL TREES ON THE PARKERTOWN ACRE.

STANDING NOW.				AFTER 20 YEARS.		
Diameter, inches	No. trees.	Volume —cubic feet.	Scale —feet board measure.	Diameter —inches.	Volume cubic feet.	Scale feet, board measure.
12-14 inclu.	9	210	840	14-16	295	1,239
10 and 11 ..	8	135	502	12 and 13	210	829
8 and 9	18	170	510	10 and 11	290	1,078
6 and 7	6	35		7.5-9	63	189
				6	15	
	41	550	1,852		873	3,335

Yearly growth in cubic feet, 16; at rate of 2.3% compound interest.

Yearly growth in feet, board measure, 74; at rate of 3% compound interest.

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*Tempered of course with the idea of business stability. Thrifty trees of medium size might too be left in a carefully considered management to obtain what the Germans call the Lichtungszuwachs, that is the growth to the largest size in an opened stand. Such a course in general would also tend to maintain the proportion of the species on the land.

So great a self-denial of present profit I have not thought it practicable to advocate or discuss in this report. That it is however not to be dropped entirely out of our consideration, the mention of it by Mr. Crawford in his outline of a conservative cutting policy, quoted on later pages, must prove. Mr. Crawford is a practical man, and he wouldn't broach such an idea if it were not within the bounds of possibility.

Growth
a) in volume
b) in scale.

Less than 2,000 feet board measure, or 550 cubic feet, is supposed to be left on the ground. After twenty years succeeding a cut, this timber would grow into 873 cubic feet or 3,335 board feet, an average yearly growth on the land of sixteen cubic feet or seventy-four feet board measure. At compound interest the yield is in the one case 2.3 per cent, in the other 3.0. This difference in rate is due to the fact that the larger a tree is the larger the scale it gets for each cubic foot of its contents.

ACRE AFTER CUTTING TO A 10-INCH STANDARD.				SAME TWENTY YEARS AFTER.		
Diameter—inches.	Number trees.	Volume—cubic feet.	Scale—feet board measure.	Diameter—inches.	Volume—cubic feet.	Scale—feet board measure.
8 and 9...........	18	170	510	10 and 11	290	1,078
6 and 7...........	6	35		7.5-9.....	63	189
				6 and 7	15	
	24	205	510	....	368	1,267

Yearly growth in cubic feet, 8.1; at rate of 3% compound interest.
Yearly growth in feet board measure, 38; at rate of 4.7% compound interest.

Heavy cutting depresses growth.

Let us now suppose the cut to be to a standard of ten inches breast high. 205 cubic feet in this case grows in twenty years to be 368, while 510 board feet grows into 1,267. The average yield is 8.1 cubic feet, being at the rate of three per cent compound interest—in board feet 38, at 4.7 per cent. Comparative results here are too important to be allowed by any means to escape. The little table annexed will, it is hoped, receive careful examination. The

AVERAGE GROWTH DURING TWENTY YEARS AFTER CUTTING OF LAND.

	Cubic feet.	Per cent at compound interest.	Feet board measure.	Per cent at compound interest.
Cut to fourteen inches	16	2.3	74	3
Cut to ten inches.....	8.1	3	38	4.7

point of it is that while much the same percentage growth is found, *the land absolutely produces far less after the closer cut.* The side which has the greater rate has on the other hand a base that is so much smaller that the resulting growth is only half as great. This is the great objection to a hard cut—it puts the producing power of the land for many years after the crop is removed down to a very low figure. Land cut to a standard of ten inches at the end of twenty years of recuperation isn't up to the condition in which a fourteen inch cut would have left it.

A practical illustration.

The value of this principle will be best seen by an application. A certain township on the lower Androscoggin was bought within a few years by the owners of a pulp mill plant who count on it for a large part of the permanent stock of their mill. Their idea as I was told was to go over the land piece by piece, cutting about four millions a year, expecting that when the ground was all cut over, it would be ready for another cut of equal size in the same rotation.

If they do have the idea that that or any other township of land, treated as timberland is in this country, will grow four millions of spruce timber a year, they are, I am confident, some time to be much disappointed in their expectations. But very much depends, as we have just seen, on how they cut their town. If they cut the mature spruce only, the large, full-grown trees which however make up two-thirds or three-fourths of all the wood on the ground, the resulting growth will be one thing. If they cut down to the smallest size marketable, while they will get perhaps a fifth more timber, they will lower the producing power of their land to a very small figure. As a matter of fact I understand the limit set in their contracts is seven inches at twenty feet. This is rather lower than the twelve inch stump limit set in the cutting on Parkertown. Just what the growth following that will probably be, may be seen in the calculation presented herewith. Using the same per cents as before, the base is the actual stand of trees left after cutting, as judged from comparison of the sample area with the results of our exploration. There will be little inducement to go back over lands cut in that way after twenty years of recuperation. That isn't half time enough for them to recuperate in, and people who really want a steady yield from their timberlands should take it to heart.

ACRE ON PARKERTOWN.

SPRUCE STANDING AFTER CUTTING TO A STANDARD OF TEN INCHES, BREAST HIGH.				SAME TWENTY YEARS AFTER.		
Diameter—inches.	Number trees.	Volume cubic feet.	Scale, feet, board measure.	Diameter—inches.	Volume—cubic feet.	Scale, feet, board measure.
12–14	4	100	400	14–16	142	603
10 and 11	6	100	372	12 and 13	155	612
8 and 9	10	80	240	10 and 11	136	506
6 and 7	4	20	–	7.5–9	36	89
	–	–	–	6 and 7	15	–
	24	300	1,012		484	1,810

Yearly growth in cubic feet, 9.2; at rate of 2.4 % compound interest.
Yearly growth in feet board measure, 40; at rate of 3% compound interest.

The Grafton acre.

But as Lessing's innkeeper said—it is not good to stand on one leg. Let us again take up the sample acre from Grafton, the stand on which was scheduled on page 105, study for a moment the relations of its trees to one another, and then, supposing a cut, first to 14 inches breast high, then to 12, and lastly of everything merchantable, or say down to 8, see what the effect on the future of the land will be.

Proportion of small and large trees.

Bringing forward the score of spruce on this acre, attention should first be again called to the relation of young to mature trees. Trees over fourteen inches in diameter number thirty; including those down to twelve, forty. Trees between six and twelve inches number fifty-seven. This, I feel confident, is approximately a representative ratio.

Considerable observation of my own on this point is confirmed by the experience of Mr. Pike and others. It may be summed up in the rule that in ordinary stands of virgin spruce the trees between six and twelve inches in diameter do not greatly out-number those of larger size. This rule, I think, will hold true not only on the Androscoggin, but on representative stands of spruce everywhere. In connection with this matter, I invite the attention of the reader to the record of sample areas given earlier in this work, which were not selected with reference to this principle.*

SPRUCE ON THE GRAFTON ACRE.

Diameter.	Number trees.	Volume cubic feet.	Estimated scale.
Over 18 inches	6	500	1,800
15–18	24	1,200	4,200
12–14 inclusive	10	290	1,160
10 and 11	12	225	837
8 and 9	24	265	795
6 and 7	21	120	
3–6	63	125	
Under 3	366	35	
	526	2,760	8,792

Of full more general interest is the relation in regard to volume and scale. Leaving out trees under eight inches, the trees over fourteen inches in diameter on this acre comprise

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* Reason for this may be seen on considering the relative age of trees of these different sizes. A six-inch tree in virgin growth like this is probably on the average 100 to 125 years of age. Mr. Pike in several hundred trees examined by him, found no eight-inch tree less than 125. The period of growth from six to twelve inches (see rule for diameter growth in thinned timber on page 123) must represent as much as seventy-five years. Trees pass the twelve-inch limit therefore, at not far from 200 years of age. Now they seldom live—as was shown in the last Maine Forest Commissioner's Report—to over 300. Therefore considering the hardiness and freedom from disease of spruce ordinarily, it seems reasonable that the trees between 125 and 200 should about equal in number those from 200 to 300.

Of course there are exceptions to this rule. There are thick growths of small trees. There are areas of young timber, grown up probably on old fires or blow-downs. I am speaking of the usual well grown stand only.

68 per cent. of the total stand, while those twelve inches and over make up 81 per cent. This is a confirmation of the idea before developed that to leave the small trees for future growth calls for no very great sacrifice on the part of the operators of the land. To keep land in constant bearing certainly is one measure of productive forestry, and this, in woods of this kind, is the way to assure it.

Computation of growth. Results.

Extracting now from the total score of trees on this sample acre those between six and fourteen inches in diameter, supposing in other woods a cut of this country for its full-sized trees only, the growth of the twenty years succeeding is then figured, using methods already explained. Next a cut including the twelve inch trees is supposed, and lastly one taking all the merchantable trees, or those down to eight inches at four feet from the ground. Readers of this report, unless they are close students, had better skip this computation, paying regard only to its results. The upshot of the matter is embraced in the following statements: The closer the land is cut the bigger the percentage of growth upon the trees left, while the actual growth in

ACRE ON GRAFTON—CALCULATION OF GROWTH SUCCEEDING CUTS OF DIFFERENT DEGREES OF SEVERITY.

(a) *Cut to Standard of Fifteen Inches Four Feet from the Ground.*

STANDING AFTER CUT.				SAME TWENTY YEARS LATER.	
Diameter—inches.	Number trees.	Volume—cubic feet.	Scale, feet, board measure.	Volume—cubic feet.	Scale, feet, board measure.
12-14 inclusive.	10	290	1,160	406	1,725
10 and 11	12	225	837	349	1,379
8 and 9	24	265	795	450	1,674
6 and 7	21	120	–	216	600
	67	900	2,792	1,421	5,378

900 cubic feet grows to 1,421—per year, 26. Rate of growth at compound interest, 2.3%.

2,792 feet board measure grows to 5,378—per year, 129. Rate of growth at compound interest, 3.3%.

volume or in feet board measure is smaller. The growth in merchantable material increases at a somewhat higher rate than the volume, partly because large trees waste a smaller percentage of their contents than small trees, partly because they scale better, partly because at the end of the twenty year period trees which at its beginning could not be considered merchantable have grown into the merchantable class.

(b) *Cut to Standard of Twelve Inches Four Feet from the Ground.*

STANDING AFTER CUT.				SAME TWENTY YEARS LATER.	
Diameter—inches.	Number trees.	Volume—cubic feet.	Scale, feet, board measure.	Volume—cubic feet.	Scale, feet, board measure.
10 and 11	12	225	837	349	1,379
8 and 9	24	265	795	450	1,674
6 and 7	21	120	–	216	600
	57	610	1,632	1,015	3,653

610 cubic feet grows to 1,015—per year, 20. Rate of growth at compound interest, 2.6%.

1,632 feet board measure grows to 3,653—per year, 101. Rate of growth at compound interest, 4.1%.

(c) *Cut to Standard of Eight Inches Four Feet from the Ground.*

STANDING AFTER CUT.				SAME TWENTY YEARS LATER.	
Diameter—inches.	Number trees.	Volume—cubic feet.	Scale, feet, board measure.	Volume—cubic feet.	Scale, feet, board measure.
6 and 7	21	120	0	216	600

100 cubic feet grows to 216—per year, 5. Rate of growth at compound interest, 3%.

0 feet board measure grows to 600—per year, 30. Rate of growth at compound interest, infinite.

It will be well, finally, to state here, what indeed must be perfectly well known to all readers, that, as a matter of fact, the cut of land to a stated limit does not remove all the trees above that limit and leave standing all the trees below. Considerable departures on both sides will be found. Scattered trees above the limit are left, while some below, if handy or in the roads, will be cut. Lastly, numerous others will be smashed down. To this last method of destruction, spruce and fir, being less pliant, are more liable than the small and slender hard woods. Perhaps the variations in these ways from the theoretical cut will balance one another approximately except in the case of a very close cut. A cut to 7 or 8 inches in thick timber will, as was seen in the exploration of Grafton and Success, leave almost nothing on the ground.

Lumbering and scenery.

It was stated along back that on ordinary well-timbered land in the Androscoggin country the large trees, such as will bring, so far as size goes, the largest market prices form two-thirds or thereabouts of the total stand. This timber is fully matured and it is proper from all points of view that it should be cut. No one questions the lumberman's right to it unless indeed those who have regard to the esthetic value of the forest. These do not appear to be many, and real consideration of their views, carrying them out to the fullest extent, would not to any great degree interfere with the use of the forests for their economic advantages. Perhaps a digression on this topic will not be amiss. If anyone has followed the thread of argument through the previous pages he will probably by this time consider himself entitled to a rest.

The winter of 1893-4 was spent by the writer in the woods, living in lumber camps, measuring trees for the U. S. Division of Forestry. After two months spent in central and eastern Maine, I went over by rail into New Hampshire in February and started in work near Fabyan's on the western slope of the Presidential Range. Getting at what I wanted there in the course of several days, I was ready to move to the next objective point, which happened to be in the Glen valley just across the mountains. Now a journey there by rail would be slow, expensive and uninteresting. A trip across the mountains would be quicker and cheaper, and in midwinter enough of an exploit to possess considerable extra attraction. So, February 27th the day after I was through work proving clear, and while cold without much wind, I got the man in charge of the Mt. Washington base station to go along to help with my pack, and assure me of getting into the right road for the descent on the other side. Together then we snow-shoed up to timber-line, sweating profusely, though the mercury was away below zero, then up over Jacob's ladder and to the summit we made a highway of the sleepers of the railway, or even of the bolts of the central track, where the gales of the summit had blown them clear of snow. Higher and higher we went, the hand of my aneroid going round the circle once and part way round again, above the timber, above the old car side-tracked, up by height after height of the surrounding land till we stood on the highest summit in New England. The country lay before us, but little that was satisfactory was to be seen. Water areas and cleared land were indistinguishable under their coat of snow. A strong wind was drawing across the mountain, and it was piercing cold. Twenty minutes was as long as I cared to stay there. Then paying off the Frenchman, I swung on my pack once more and started down the east side for the Glen House. First on the hard driven snow of the summit, later following the turns of the road which now in many places was blown full to an even slope both up and down the mountain, lastly through the timber on snow-shoes or sliding down the stretches of glare ice where the brooks in warm weather had overflowed the road. It was a delightful trip, just a pleasing variety for an active and cool-headed man. Arriving before night at what was left of the old Glen House, next day I took up my work and my abode in the concern of the Libby's of Gorham.

Mt. Washington in winter.

The valley of Peabody river in which the Glen House was located, is a deep gorge between Mts. Washington, Jefferson and the others that make up the Presidential Range, and the lesser range to the east, in the direction of Wild river. At the outlet of the valley, at Gorham, are the mills of E.

Libby & Sons, and their supply of logs comes from this locality. Beginning at the lower end of the valley and on the lower slopes of its sides they had gradually worked back and up until they had nearly cleaned the valley of spruce back as far as the Glen House and up to a height of 2,000 feet above the stream, which was about as far up the mountains as lumbering by present methods could go. It was a hard country to lumber. A fall of 2,000 feet in two miles makes a pretty steep road, one on which bridling and snub-warp and all the other devices of rough-country operators are required.

Mountain lumbering.

Cutting, it was said, had gone up to about 2,000 feet on the mountains each side. The spruce had naturally been thick, and the land was consequently left in pretty ragged condition. The destruction was evident, not only from the inside, but, to a practiced eye, from the outside also. But few places had been cleaned of trees entirely, a few very steep spots where the spruce was pure and from which it had to be sluiced, but on the cut-over portions of the country there was an absence of evergreen tops showing, in marked contrast with the condition of the virgin country. From the hills on one side of the valley, the best idea could be gained of the condition of the opposite slope. Not only the absence of evergreen tops, but the broken surface of the crown cover, and the way in which the snow showed up through it, indicated with perfect distinctness, the boundary of the region cut. Further up the valley, however, the timber had not been touched. It was a magnificent stand. Along the road up the mountain, particularly, was a considerable stretch of country in which, except to cut the road, no ax had ever been struck. In fact, lumbering had then only crossed it in one place.

Scenery and the lumberman.

Not long after I got out of the woods from this cruise, I happened to meet an old and frequent visitor in the White mountains. It was a lady whose general love of nature was highly specialized in the direction of trees. In fact she loved trees very much, she was highly interested in the agitation regarding the destruction of White mountain forests which was then going on, and her pet and particular ambition was some time to see a piece of forest in its primitive condition, untouched by the hand of man. At that point in the conversation I began to evince a rather particular interest. I inquired particularly to what points she had been, where her rides and walks had taken her, and then I informed her, very much to her amazement, that she had seen and traversed many miles of virgin timber.

About that time I got an insight into the White mountain agitation that tallied very well with impressions received from the reading of numerous magazine articles then current. I thought of the artist that Frederic Remington mentions who painted a picture called "The Forest Primeval" but inconsistently chose his scene in second growth. Opportunity again occuring to learn the impressions of White Mountain visitors, I gladly availed myself of it.

This time it was a gentleman of prominence, a college professor whose intelligent interest in all around him and whose powers of observation, too, one would think, must have been much greater than those of the average visitor. He had spent many summers in the mountains. Within a year or two he had ridden from Jefferson round the north end of the Presidential Range to the Glen House, passing thus through the very region where I had been at work in the spring. I inquired as to his impressions of the valley. Plainly it had not been hurt for him. For all he knew it might all be virgin growth. In short, those mountain sides from which lumbermen had taken everything they wanted, at a little distance and for scenic purposes were just as beautiful and satisfactory to this intelligent tourist as virgin timber would have been.

That in fact seems to be the case in general. Certainly as long as evergreen trees are the staple of the cut the interests of the lumbermen and of the sight-seer will not at many points clash. For scenic purposes hard wood is as good as spruce—even second growth, which in this climate quickly covers almost every stripped or burnt piece of ground, is after a few years and at a little distance quite as satisfactory.

Along travelled roads and close about places of resort of course the gashed-up country and the debris left by a logging operation are not ornamental. At such points however protection could be secured without great cost or sacrifice.

This White mountain problem, I may be pardoned for saying, was in its time made too much of. It is a good thing that it has been dropped. Doubtless the country owes much to those who carried on the agitation. That agitation, however, was doomed from the start to bear no direct fruit, because those who carried it on failed for one thing to get at the lumberman's point of view, for another to master in detail the real facts of the problem with which they attempted to deal.

Amount and value of small trees.

It was shown some distance back that two-thirds or three-quarters of the original stand of spruce is in the shape of full grown trees which it is right should be cut. Their growth pays the owner of the land little or nothing. The interest of the community runs to the same effect. The other third or quarter only is the subject of debate and inquiry. If the greater part of this be cut in addition to the mature timber, the effect is to almost blot out the spruce growth upon the land for many years, and also generally, by leaving other species in special prominence on the ground, to give them great advantages in recovering it. The spruce growth for a period of years is blotted out, while the prominence of spruce on the land is damaged for all time. This effect the lumberman greatly enhances by adding, say, a third to his cut of timber.

But though these trees may add that proportion to the amount of the cut, they do not similarly increase its value. The small trees which make up that last third cost more to handle because of their small size, and they are not worth so much in the market. Saw mills are still predominant on all our rivers, and their demand for logs of good size keeps up a difference in the price of large and small timber. Just what this amounts to no one can absolutely say. It seems to vary at different points on the Androscoggin, the difference in price being variously set at from one dollar to two dollars per thousand.

Similarly with cost of logging. Some men say that when their roads are in, they can cut down to the smallest limit of trees (to eight or ten inches at breast high) as cheaply per thousand as they can cut the larger lumber. Yarding* they say costs the same—the only way in which a difference comes in is on a long haul. On these points I have to take the testimony of those who have had experience, and this is what most of them say.

The question now arises—how much comparatively are trees of different size worth as the axeman steps up to them in the woods? Certainly on land cut on stumpage the smallest could hardly be handled at all, for they cannot, over and above expense of handling, pay an even rate of stumpage based on the value of the larger trees. Most lands on the Androscoggin, however, are not operated in that way. The land owner and mill owner are one; frequently lumbering, too, is directly run by the same party. The values that we must set are simply the difference between the cost of cutting and getting to market and the value of the timber when it is there. Putting together what facts I could learn, and especially assisted by my friend, Mr. Pike, it seems that the figures set below are not far from representing the general conditions of the country. If trees over fourteen inches in diameter are worth standing three dollars per thousand, those from ten to fourteen may be worth two

Value of small trees standing.

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* Yarding, it may be well to state for the benefit of readers who are not familiar with New England lumbering, is bunching the logs from a district together alongside a main road. The lumber from a few acres or from a large district may be so brought together and rolled up into one pile. This work may be done in autumn or summer, the logs being dragged by horses one or a few at a time from the stump to the yard.

Hauling from the yard in most cases has to wait for snow, not only because sleds transport easier a heavy load than any other kind of horse vehicle, but because snow grades and levels the roads. Ordinarily, the lumber is hauled from the yard to a stream or lake and is carried to the mill by water. Logs may also be yarded to a railway. What in Maine is called a yard, in Michigan is known as a skidway.

dollars, while trees smaller than that might be considered to net one dollar.

If this were exactly true, it would establish two critical points which would have to be specially considered in discussing the growth of land. Such points there are, though not generally sharply defined. They cannot all be taken account of in this report, but it is hoped that with the figures determined by this work and the illustrations of their application that are also given, men will be able to figure for themselves. The figures for value in this case materially affect the growth calculation. Applying them to the acre from Grafton, I find that while trees fourteen inches and under form about one-third of the total amount of merchantable timber by scale they form only one-fifth of its value. Of the stand of the Parkertown acre trees of the same size form twenty-six per cent of the stand while comprising at the rates named but sixteen per cent of the value. More striking is the contrast when the cut is supposed to go down to twelve inches at breast high. On the Grafton area the trees between eight and twelve inches comprise twenty-one per cent of the timber, while they form but eleven per cent of its value. On the Parkertown acre the per cents are fifteen and eight. These figures show that comparatively small values are involved, that the sacrifice of present profit the lumberman has to make to secure to himself a considerable future growth upon his land is but small*

Growth in value. Its rate greater than that for volume and scale.

Nor is this the only point to be considered. The increased value per volume which added size gives affects not only the value of standing trees, but it materially adds to the value of growth. The trees left standing at a cut if in twenty years they have grown two and one-half per cent. in size, in scale may have grown at three and one-half per cent., in value at four or five. It is value of course and not amount that men are concerned with in studying the growth of land. Let us take the Grafton acre, suppose it cut evenly to a standard of twelve inches, and find out the growth in value on the land. I bring over the amount of scaled timber standing after the cut and the amount after the growth of the next twenty years, and to them apply the values per thousand that have recently been stated. The same thing is next done for the Parkertown acre supposed cut down to a standard of fifteen inches. The increase in value from these various sources figures 4.5 and 5.2 per cent.*

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*I have it on the best authority that in a clean cut to 7 or 8 inches breast high the logs of first quality—that is, those of large size exclusive of seamy and very rough logs—form a fair land about two-thirds of the cut.

ACRE ON GRAFTON CUT TO STANDARD OF TWELVE INCHES FOUR FEET FROM GROUND. VALUE OF GROWTH UPON IT IN TWENTY YEARS SUCCEEDING.

STANDING AFTER CUT.					SAME TWENTY YEARS LATER.		
Diameter—inches.	Number trees.	Scale—feet board measure.	Value.		Scale—feet board measure.	Value.	
10 and 11	12	837	At $2 per M...	$1 67	1,379	At $2 per M....	$2 76
8 and 9	24	795	At $1 per M...	80	1,674	At $2 per M....	3 35
6 and 7	21	–		–	600	At $1 per M....	60
		1,632		$2 47	3,653		$6 71

1,632 feet board measure grows to 3,653—per year, 101. Rate of growth at compound interest, 4.1%.

$2.47 in value grows to $6.71—per year, $.21. Rate of growth at compound interest, 5.2%.

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* One matter has been omitted from consideration here. It seemed impossible to bring it into the computations, and yet it ought to be clearly stated. Two thousand feet of lumber standing on an acre of land is not as a rule worth two-fifths as much as five thousand standing on the same area. The reason is that being more scattered it costs more to get it. Thus two thousand of small trees taken with a larger stand are worth more to cut then than they are afterwards, until at least a considerable stand has been replaced. So the 3653 feet of the Grafton acre twenty years after the cut might not be worth the same per thousand as the 1632 feet left in the cut would be *to take it away with the rest of the original stand.* Of course an increase of values might reverse that.

ACRE ON PARKERTOWN CUT TO STANDARD OF FIFTEEN INCHES FOUR FEET FROM GROUND. VALUE OF GROWTH UPON IT IN TWENTY YEARS SUCCEEDING.

STANDING AFTER CUT.					TWENTY YEARS LATER.		
Diameter—inches.	Number trees.	Scale—feet board measure.	Value.		Scale—feet board measure.	Value.	
12-14 inclusive	9	840	At $2 per M...	$1 68	1,239	At $3 per M....	$3 72
10 and 11	8	502	At $2 per M...	1 00	829	At $2 per M....	1 66
8 and 9	18	510	At $1 per M...	51	1,078	At $2 per M....	2 16
6 and 7	6	–		–	189	At $1 per M...	19
		1,852		$3 19	3,335		$7 73

1,852 feet board measure grows to 3,335—per year, 74. Rate of growth at compound interest, 3%.

$3.19 in value grows to $7.73—per year, $.23. Rate of growth at compound interest, 4.5%.

Growth—its ratio to land values.

Lastly the value of growth has to be considered in still another way, in relation to the value of the land. Land that has been cut through rules at a very low rate oftentimes, because most every operator thinks he has cut everything it will pay to cut, and most have but very hazy ideas of growth. Yet such land, examined as the country has been in the course of this study, may be proved to have considerable small or scattered spruce upon it. Most of the land explored on Parkertown for instance, while cut only with the idea of getting all the timber off it that could be got, yet was shown to have enough spruce remaining on it to grow an average yield of some thirty-five board feet per year. If now, in the computation of the value of growth upon it, we take as a base, not $1.78, the value of the standing wood at the rates just used, but one dollar as the market value of the land, the product of twenty years' growth bears a far greater proportion to the starting base. A gain of seven per cent. at compound interest is thus put on the land by growth. Perhaps of all the figures given this is the one which is most applicable. The value of growth in its relation to the market value of land is the thing which men most frequently want to know. It is an entirely different matter from the rate of growth of trees in volume, though it is dependent upon it.

Summary of results.

It will be well, probably, to sum up the results which have been worked out in the preceding pages in connection with the two sample areas named. At the same time it must be said that no example or pair of examples can possibly meet the conditions of all cases. The factors vary in each case. Cutting and scaling methods used, rates for timber of different sizes, methods and cost of transportation, all these matters are different in each case, and they influence greatly the value of growth and consequently the attitude that should be maintained toward it. The most that work of the nature of this can do is to furnish some of the general factors in the calculation, elements, however, of great value that have not up to this time been determined.

The following statements embrace the results of the foregoing computations. The examples used were meant to be as representative as might be of Androscoggin conditions in general:

Growth on small timber left in a moderately hard, systematic cut of land may be set at the rate of two to three per cent, compound interest, when volume alone is considered. The rate rises or falls as the cut is more or less severe.

Measured at start and finish by the Maine scale rule, the same growth in volume might mean an increase in scale at the rate of from three to five per cent. It might mean a much larger rate, according to the ideas of the person viewing it.

Putting a fair relative valuation, size being taken into account, on the timber standing at start and finish, the increase in the value of timber so left due to growth might be at the rate of four to six per cent.

The rate per cent that annual growth bears to the market value of land is a very different matter. It may very greatly overrun the figures which have just been set.

Quite as important as these rates per cent, both for immediate and private consideration and in connection with the long-run productiveness of land, is the absolute amount of growth, especially as affected by the severity of a cut, the amount of timber which cutting leaves on the land. A hard cut not only decreases so much the more the visible stock of timber, but it affects future supply often to a greater extent by depressing the growing power of land.

These general statements the reader is asked to interpret in the light of the examples and the qualifications that have gone before. Careful consideration of what has preceded, picking out essential factors as they have been determined and modifying the variable ones to fit, will enable men, it is hoped, to work out for themselves their own individual problems as regards the growth of timberland.

Future of the Androscoggin.

The computations which have preceded, not only hold relatively among themselves, but they have value because, used with good judgment, they tell very much about the production of the country and the prospects of future supply.

Standing spruce resources.

In making general the results worked out, the first thing to be considered is the relation of the sample areas dealt with to the average stand of the country. In this comparison Mr. Pike's estimates come in play, with ascertained figures as to the area of the spruce-bearing country. Mr. Pike's estimate puts on the Androscoggin drainage in Maine 3,600,000,000 feet of spruce lumber. Now the spruce-bearing area as early defined foots up according to my reckoning about 1250 square miles, from which must be thrown out for water areas, settled land, burns of greater or less age and other items of waste about 400 square miles. 830 square miles, or 531,000 acres, therefore, must bear the total stand of spruce. This makes the average stand 6,800, and as just about half the area has to some extent or other been cut through, the average natural stand of the country should probably be set as high as 9,000 feet. Our sample areas, therefore, scaled as near as could be judged to their actual yield, appear to be representative of the country in general.

Comparison with other rivers.

These figures, however, must be qualified before they can be compared with similar figures from other parts of the state. Mr. Pike's estimates include trees down to the smallest size cut in the region, the cutting there being in fact much closer than that practiced in most other parts of the State. Of the trees cut down, too, Androscoggin lumbermen are as a rule much more economical than others, while on the average they give their timber probably a somewhat more liberal scale. Mr. Pike's three and one-half billions of spruce, on the upper waters of the Penobscot or St. John would hardly be set, I think, as high as two billions. In other parts of the State it would pass for a varying intermediate amount.

Outline of a conservative cutting policy.

Our sample areas, however, are thoroughly typical. From consideration of them it appears that conservative cutting, cutting that has reference to the steady production of spruce on the land, would stop probably with trees somewhere about fourteen inches at breast high, taking thus the full grown trees, those of full size and greatest value, leaving the smaller for a period of at least twenty years untouched on the land. By this means an annual growth of somewhere about one hundred board feet per acre could be derived from the land. This gain could be permanently received supposing a similarly conservative cutting policy to be continued, supposing too, the natural proportion of spruce in the stand to be permanently maintained.* Scientific forestry of course, could largely increase that production, but of that we are not now speaking. The desirable condition is to have the land well stocked with small and medium sized trees from which at intervals the larger can be taken. The future cuts, if land were to be used in this way, would take out trees probably at from twelve to sixteen inches.

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*A question is raised here whose discussion for clearness' sake is deferred.

One hundred feet per acre then may be taken as the upper limit for growth upon the land, the reward of a cutting policy which is practical and business-like but which has regard not merely to immediate profit but sacrifices something in the present to the future value of the land. The yearly growth of a full township at this rate is about two millions, and that of the whole drainage of the Androscoggin in Maine from fifty to sixty. Certainly, as things are running now, and as they are likely to run in the immediate future, no such yield is to be expected. On much land, and for many years, not half of that amount. The close and systematic cutting practiced, equalled nowhere else in the State so far as I have seen, shoves down the producing capacity of the land to an extremely small figure, and defers to a period distant from forty to one hundred years the time when it will be worth while to again cut spruce from the land. But this condition is not without its hopeful aspect. It is due to the thorough-going way in which business is carried on on the Androscoggin, to the system and organizing ability of Androscoggin busmess men. Those men when the facts are known, if they warrant it, will be far more likely to apply them to advantage in the shape of a conservative cutting policy than those who still practice the wasteful and hap-hazard methods of forty years ago.

The Androscoggin drainage from the spruce point of view is the best worth study of all the rivers of the State. It is also the one in my judgment on which a conservative forest policy is likely to go first into effect.

As to the future of the region further and more definitely, that is so much a matter of the future, as one might say—so much depends on the development of business and the determinations of a few men—that prediction must be made with very large conditions. The Androscoggin mills we know are highly favored in position. Even now they bring from Canada by rail a portion of their pulpwood supply. As to their own natural territory, however, this can be said—and I cannot believe that any man who knows the volume of spruce consumption on the Androscoggin and at the same time has any actual knowledge of its timberland and lumbering methods, will dissent—if cutting methods, the most sweeping and thorough anywhere practiced, are maintained, and especially if the volume of the pulp and paper business keeps on increasing at the rate of recent years, Androscoggin business men, however bright the prospect seems now, will at the end of but a very few decades find themselves face to face with a blank wall. Prediction as to the Kennebec is difficult and uncertain, because of the variety in the stand of timber, the size of the drainage, the length of time which it has been worked, the variety of lumbering methods practiced, both in its past and present. On the Penobscot the same things, operating to a prolongation of its supplies beyond all expectation, are to a much greater extent true. On the Androscoggin no such things hold. Its resources are great, but they are in that compact shape which in rendering them open to accurate estimate, leaves them liable to total extinction by the lumberman as well. There can be no doubt about it. The problem here is little more than one in simple division. We must choose between having our cake and eating it, or, better, adopt that third alternative which growth and reproduction in all living things render possible—take and use such as is grown and fit, and assure ourselves by conservatism and moderation in leaving the stock necessary for reproduction and growth, of a steady future supply.

Statistical summary.

Nothing remains now but to record the statistical material relating to the Androscoggin river which it has been possible to collect. First is Mr. Pike's letter relating to the stand of spruce timber on the drainage. Next comes the study of the acreage of the region so far as it relates to the problems in hand. In regard to water areas, the figures given in Well's "Water Power of Maine" have in this work usually been followed. In the case of the Rangeley lakes, however, the manuscript map of the region compiled by Daniel Barker, a copy of which, along with other valuable data, was kindly furnished from the office of E. S. Coe, has been taken as authority, as it embodies later and more accurate surveys. The outlines of the burns and similar data were recorded on maps as they were obtained in the field or by inquiry, and they are ready for publication in that form whenever the State provides means for the purpose. Much of this information, however, would have little meaning on any other than a topographical map, and whoever believes in study of our forests, or the study from any point of view of the natural resources of our State, should concentrate his energies on the inauguration of such a survey. A topographical map is the basis of all study and record of the natural features and resources of a country.

Lastly, against resources in hand and the prospect of growth, is set the consumption of the mills. These are divided into saw and pulp mills. Both lines of business are yet on the increase.

Letter of Mr. J. A. Pike relative to spruce standing in the Androscoggin basin:

BERLIN, N. H., DECEMBER 9, 1895.

To Austin Cary, Esq., Bangor, Maine:

Estimate of spruce timber in the Androscoggin basin at and above Rumford Falls including saw logs and pulp stock. This estimate includes all that naturally goes to Rumford Falls.

At and above Berlin in Maine	3,000,000,000
Below Berlin	600,000,000
....	3,600,000,000
At and above Berlin in New Hampshire,...	700,000,000
Below Berlin	200,000,000
....	900,000,000
Total	4,500,000,000

This estimate is based largely upon personal examination and entirely upon personal knowledge of the territory and the character of the growth and after consulting notes and memoranda extending over a period of more than twenty years.

Very truly,

J. A. PIKE.

Asked to be more explicit as to the standard of cutting, on which his estimates were based, Mr. Pike refers to the cutting on Grafton and Success, the closest in the country, described in the first portion of this Androscoggin report.

AREA OF ANDROSCOGGIN SPRUCE LANDS IN MAINE.

	Square miles.	
Gross area naturally spruce bearing*		1,240
Waste, burnt within thirty years	21	
burnt more than thirty years ago including old second growth in settled towns.	234	
settled (on very poor data)	65	
water areas	75	
unproductive mountain land, etc., say	15	410
Net area spruce-producing land		830
Area never cut for spruce, about		420

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* Including on the south Batchelder's Grant, Gilead, Newry, Andover, Roxbury, Weld.

CONSUMPTION OF SPRUCE ON THE ANDROSCOGGIN RIVER FOR THE YEAR 1895.

	Sawed.		Used for pulp and paper.	
At Berlin	40	millions	60	millions
Gorham	10	"		
Shelburn	10	"		
Rumford			24	"
Canton	2	"		
Jay and Livermore			19	"
Lewiston	*6	"		
Lisbon	4	"	†11	"
Brunswick and Topsham	‡1½	"	§9	"
	73½		123	

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*This item very variable.

†Of this item about 1-6 in 1895 comes from the Sandy river.

‡This comes 1895 from Kennebec river.

§Nearly all of this item brought from Canada by rail.

About ten millions sent from the neighborhood of Berlin to be manufactured off the drainage.

Additions to mill capacity made in 1896 indicate an increase of consumption of forty millions. Twenty-five of this is at Berlin, for pulp; the remainder is about equally divided between a saw mill at Rumford, and a new pulp mill plant at Peterson's Rips in Livermore.

Several Androscoggin pulp mills use a small amount of pine and poplar. The mill of the Poland Paper Company at Canton uses poplar entirely.

TOPICAL DISCUSSION.

In the narrative which precedes, much that might have been said has of necessity been omitted. Some of these matters, with others related to the main purpose of this report, it is now designed to take up in the shape of topical discussion. This will be arranged under three major heads—first, the distribution of spruce in Maine and a description of the usual stands in which it occurs with some suggestions as to their management; second, an examination into current methods of measuring lumber; third, I shall endeavor to state what genuine forestry in connection with the spruce resources of Maine seems to mean.

DISTRIBUTION AND USUAL STANDS OF SPRUCE IN MAINE.

The plateau region of Maine.

The distribution of tree species is related to the topography, soil and climate of a country. Wells' "Water Power of Maine," several times referred to in this report, gives us far better than any maps in existence the conformation of the capitol. The ruling topographical feature of the State is the White Mountain Plateau stretching out eastward from northern New Hampshire, bearing the Rangeleys and Moosehead Lake, and ending at Mars Hill on the New Brunswick line close to the St. John river. The axis of this plateau runs as indicated, in a direction somewhat north of east, determining gentle slopes north and south from it. It is a broad plateau, not a well-defined watershed. On it all the great rivers of the State have their source, their head waters interlocking and sometimes interflowing. Thence they run north, east and south, to widely separated outlets in the ocean. The greatest height of the plateau is at the west, near its source in the White Mountains. Here lie the Rangeley lakes at a height of about 1,400 feet above the sea. Moosehead, at the center of the plateau, is called 1,023. The general elevation of the country about Mars Hill is much lower.

This the home of spruce.

The occurrence of spruce* in the State is in close relation to this topography. In the high and rough lands of northern New Hampshire stand probably the largest and finest spruce trees to be found anywhere in New England. Heavy and fine stands of spruce timber are likewise found, the average of the country being far beyond what it is in central and eastern Maine. To this region the country surrounding the Rangeley lakes naturally joins itself. Still high and rough, left too by the continental glacier with but little soil, it is a natural spruce country. Stands of mixed spruce and hard woods are most frequently seen, but spruce nearly pure covers the mountains and the specially rocky levels. It is sometines a matter of surprise how little soil apparently it takes to maintain a magnificent stand of spruce.

East of the Rangeleys there never was, the country over, such a stand of spruce timber. There is more hard wood in the country, and, it appears to me, more swamp land etc., land that is waste in respect to all kinds of timber. Great areas of pure hard wood occur all over the waters of the Kennebec and Penobscot, and the mixed land does not have on the average so large and even a stand of spruce. Only in certain districts, generally mountain districts, as in the country about Lobster lake or in the mountain land in the neighborhood of Ktaadn, do any such heavy spruce stands occur as on the Androscoggin and in New Hampshire are plentiful.†

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*By spruce is generally meant in this report the black spruce, *Picea nigra*. It is seldom that *Picea alba* forms more than a very small proportion of the stand in our forests. Its frequency about towns, on old run-out pastures and fields, is much greater than in the original woods.

†The stand of spruce on the Maine plateau increases thus from east to west, from the lower to the higher portion of it. A striking corroboration of the statements here made is to be found in the yield which in the different parts of the region is considered to be a good one for a spruce town. Lumbermen on the eastern Penobscot and in the Aroostook country as I understand consider fifty million feet of spruce a large amount for a town to yield. In the neighborhood of Moosehead are townships which have cut 100 million. On the Androscoggin the maximum yield is not less than 200. Part of this difference is due to difference in scaling and cutting methods. More of it, however, must be due to the natural stand, and the most general and clearest feature behind that is the difference in vertical height.

Still greater decline in respect to spruce is seen as we leave the great plateau and go off to its lower and more fertile edges. In the lower lying and better soiled portions of the Aroostook country stand the finest hard woods anywhere to be found in the State. These are mixed, of course, with evergreen trees to some extent—Aroostook indeed is said once to have had some of the very finest pine—but the better and typical portions of Aroostook neither have now nor ever did have any large amount of spruce. The soil conditions are too generous. Other species are more appropriate to them. Similarly on the southern borders of the great plateau. The lower towns of the Penobscot and Kennebec gradually lose their spruce, while west of the Kennebec where the boundary of the elevated land is sharper, the fall-off marks as sharply the distribution of spruce as timber. Travellers by rail along the mellow lands of the Androscoggin and Sandy rivers, surrounded by pine groves and the familiar hard woods of Maine, may yet be assured that but a few miles away, in the mountains of the background, lies some of our finest spruce-bearing country.

White birch follows spruce.

Not exactly part of our subject, and yet so closely related to it that it should be here mentioned, is the distribution of the white and gray birch, *Betula papyrifera* and *Betula populifolia*. Of these two species, the former in the climatic and topographical conditions which it seeks follows very closely the spruce. The latter, on the other hand, seems somewhat less hardy than pine. The finest white birch groves ever seen by the writer stand on the shores of the Rangeley lakes—exactly the location of the finest spruce that the State possesses. Twenty miles south on the other hand, on the low and sandy lands of the lower course of the Androscoggin, the birch seen is quite as uniformly the gray. Neither of course was a large element in the natural forest, but they have come in largely on burnt and cleared land. The dividing line between them, going with the topography of the country, is fairly sharp and clear.

Further east too, the relations are such as would be expected. About Moosehead lake, and on the higher parts of the plateau in general, the white birch, of these two species, is the one far most commonly found. It is in fact one of our hardiest species. On elevated sites it distances most of its competitors, and climbs, with the spruce, fir and mountain ash to the top of the highest peaks within the State. On lower ground in eastern Maine, however, white birch like spruce gradually gives way. In the southeastern counties and along the railway east of the Kennebec the two species will be found mixed. Beyond the southwestern angle of Maine, white birch, otherwise than botanically speaking, is not found. The close similarity therefore of white birch and spruce is plainly to be seen.

Spruce-bearing area of the State.

It will be well to mark off roughly the spruce-bearing portion of Maine, meaning now by that not the botanical distribution of spruce, nor even strictly its occurrence as lumber, but rather the district through which it is so considerable a portion of the forest growth as to be a prominent feature of the lumber supply. So defined, the area occupied by the species might be said to be bounded on the south as follows: From the west line of the State by the Androscoggin river till it takes its turn south at Rumford; thence by a line drawn to the north line of Bingham on the Kennebec river; thence east along the Piscataquis river to the main Penobscot. The country east of the last named river, including mainly to the south the rough lands of Washington and Hancock counties, may be said to be practically spruce-bearing. All our territory north of this line must be so considered, great as the variation is within it. Spruce once clothed, too, and does largely yet, a strip of country all along the coast. Of our total area of 31,500 square miles 22,000 may thus be classed as spruce-bearing.

Relation to soil and temperature.

If the distribution of spruce within the State has been described in relation to the topography, it is no less evidently related to soil and climate. The district described embraces the roughest and poorest lands of the

State, those with the rockiest and scantiest soil. Within that distribution it is on precisely the most meager soils as a rule that spruce is most prominent in the natural growth, while the more fertile and better drained regions are turned over to predominant hard woods. With elevation in vertical height, too, goes cold and roughness in climate, and it seems to be precisely that degree of rigor which in our State is secured by the highest general elevation of the land that ministers to the finest development of spruce. These elements, of course, affect the result in combination, and the effect of each would be hard to disengage from that of the rest. In general, however, their weight in the connection is clear. Spruce seems to love the roughest conditions that our State has to offer. The coldest slopes, the highest elevations barring the actual mountain tops, the most meager soils down to those which it itself produces and maintains are conditions on which spruce thrives. Here it is at home. Here it is easiest for it to maintain its predominance over other native species.

A brief consideration of just how spruce stands in our country will be of value. If it is to be a topic in literature a nomenclature should, for convenience and accuracy of designation, be established. That will not here be attempted. For that we should wait till more thorough and rounded study of our forests has been made.

Spruce standing in hard woods.

Little of our spruce is found in pure groves. Much of it indeed stands on what is really hard wood land—land, that is, on which deciduous trees form not less than two-thirds or three-fourths of the natural cover. Here, in fact, it is common knowledge among lumbermen, are found the largest and finest spruce trees. The usual maximum height of spruce in Maine might be fairly set at eighty feet, and two feet at breast high is a large diameter. These dimensions are attained as frequently as anywhere in hard wood land.

Fine quality also seems to go along with this situation. Great length in a tree ensures that it tapers slowly, and consequently yields well to the saw. Spruce in hard wood indeed is said to be hard to estimate standing on account of the deceptive size of the trees and their unusual length of body. Internal quality of timber, too, in such situations is high. Spruce grown in hard wood is less likely to be racked and split by the winds than that grown on more exposed situations. Its wood, too, is more often clean, white and even in grain, qualities which seem to go along with the character of the soil. On the same factor depends the fact that spruce in hard wood land are rapid-growing. A good stand of hard wood is a sure indicative of a liberal and well drained soil. This advantage the spruce also utilizes. It grows rapidly. Its annual rings of wood are thick. A hard wood country that has a liberal mixture of spruce in it is for numerous reasons, particularly if there is considerable young spruce, apt to be valuable property.

Future management.

How does such land act after cutting? What is its prospect as a future producer of spruce? That depends upon the amount of young growth and the way in which the land is treated.

Probably in all stands there is enough young spruce to keep constantly replaced *under natural conditions* the stock of mature trees. It often seems not to be the case, seems as if there were not enough trees, say from six to ten inches in diameter, on the ground to replace the original crop. Consideration of the facts, however, convinces us that this must be the case. In the first place we must remember that natural stands of timber are the product of forces which are constant or nearly so. The place that one species has won for itself it is altogether likely it has the power to maintain. Other considerations moreover help us to believe it. It takes but ten mature trees per acre to make a fair crop on such land, and probably as many more between six and twelve inches in diameter—an amount and quality of timber which on most observers would make no impression whatever—are all that within those dimensions are required to replace it.* But replacement after cutting it will take time to make. The growth of an inch in diameter means six or eight years. With clean cutting, the original crop will not be regained in less than forty.

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*For the justification of this view see page 132, note.

Neither can we count on the yield of land treated in that way being maintained. Continued cutting of spruce, leaving its competitors to stand, puts that species at a great disadvantage. The hard woods in such places spread their crowns, shade over the openings, and put a damper on the progress of the young growth beneath. Then the new growth in such places is not characteristically spruce. Dwarf maples are most frequently the first growth, mixed of course with a variety of species, of which yellow birch and maples seem to be most common and lasting. Spruce may be present, but in competition with the more rapid-growing hard woods it is badly left behind. The fact seems to be that by cutting out the mature spruce we have destroyed the balance of seed supply on which for one thing the original proportion of spruce was dependent. Continued cutting must have a great effect in this direction and in time it will be felt. It is perfectly evident in fact that persistent cutting of a species puts that species at a vast disadvantage.

The earlier effects of this kind of treatment were often observed during the summer's travel and some points have been spoken of in the narrative. Its final results would be best seen in the older timber lands of the State, from extended exploration of which I have been prevented. To counteract this tendency of one-sided cutting I propose that an effective measure would be to girdle hard wood trees. This will have to be done with judgment, because the time may not be far off when much of our hard wood will itself be valuable for lumber. There are always worthless trees, however, crooked and forked specimens that never will be worth anything, and these may without harm be destroyed. No harm can be done, that is, if growth is not so open as to be exposed to wind, and the advantage which this measure would give to the young growth on the ground, and particularly to the start anew of desirable species, it seems to me would be considerable. Such a measure, of course, would involve the training of woodsmen.

Protection against fire.

There is another way in which this characteristic stand of timber should be considered. That is in relation to fire. Hard wood or mixed land is not nearly so liable to destruction by that means as is predominant spruce growth, and that fact has a bearing in two directions. In the first place it increases the value proportionately of hard wood land, and in the second place it shows us that that kind of land scattered through a country serves the purpose of fire protection. Its use in that way, it seems to me, is in the future likely to be taken advantage of and extended. Careful study of the lay of hard wood ridges and streams might show us how, aided by the laying out of lines of road or other belts on which fire could be fought to advantage, a region could be broken up into sections with fire-proof lines between. Another measure in the same direction would be the breaking up of the area cut over on a tract. When men start to cut over a township, the usual practice now is to begin at one point and extend the cut in one body from that center, so that, the old choppings being particularly liable to fire, fire if once started burns through a large area. Now against the majority of fires, virgin timberland of whatever nature is proof. If, then, the cut-over area instead of being in one body were broken up into several, a single fire once started would mean probably but little damage in comparison. The principle involved here is one well established in European forestry. There, of course, it can be applied on a much finer scale.

Black growth.

All through northern and eastern Maine are considerable areas of land cleared by the glacier of all movable material, or on which it left only a layer of boulders. Here, however, we find to-day in most cases a growth of timber. The weathering of centuries has served to wear something in the way of soil from all but the most refractory rocks. The decay of moss, leaves and wood has served to create a layer of vegetable material which in its turn furnishes nutrition and anchorage for present tree growth. Such sites as this in Maine are generally wholly or largely occupied by spruce.

Growth in which spruce is predominant is known among woodsmen by the very descriptive name "black growth" or "black land." Another feature by which it can be marked is the nature of the soil cover. On hard wood land the fallen leaves cover the ground, often deeply and unbrokenly for long distances. Where spruce rules, however, the ground is sure to be covered with moss.

Black growth, however, must be divided into two or three classes. First among these is a very rapid-growing, thrifty kind of land which I think does not occur in very large tracts in this state. My impression is that it is oftenest land whose bottom is slate. Such rock is friable and porous, and some little soil is sure to make and lie upon it. It is generally broken up into ridges and knolls which makes the drainage good and keeps off standing water. Such land, even with extremely little of mineral soil, is favorable to the growth of spruce, as the tables for growth given in the appendix will show. When mixed with a proportion of hard woods to shield it from wind, this land is in best shape to grow spruce permanently. Brassua would have been a fine township to handle in that way, cutting out the full grown timber and leaving the smaller carefully to grow. Some townships indeed have as a matter of fact, though undesignedly, been treated roughly in that way. Tomhegan is probably a case in point, the township on the west shore of Moosehead which Mr. Oliver Mansell of Greenville has cut on each year for nearly thirty years. He has not cut the town over systematically, but each autumn he has located his crew in the best country he could find on the township. He has never cut pulp. Probably he has never cut very clean. What timber was left has not to any great extent blown down. As a result the township, being naturally thrifty land, has produced well and still maintains its producing power. Other townships on the other hand of a little different character might by this kind of treatment have been robbed of almost all value.

Liability to fire and wind.

Black growth land is at certain seasons of the year liable to fire, and fire on such land works especial damage, because it destroys not merely the timber but the soil. Aside from that, the chief problem in its management with a view to growth seems to be protection from winds. Such country grows fast and if reasonably cut the growth is of an amount that is well worth waiting for. Yet leaving the land too open may leave it subject to winds which may in the course of five years after a cut, without the assistance of any unusual gale, knock down more lumber and destroy more value than the land can grow in the next twenty. Every piece of ground is in this connection a problem by itself. Most men face to face with it will give it up and take what they can get from the land now.

Unthrifty spruce land. Its marks.

A second well-defined type of spruce land is much slower growing, and the problems relating to its growth and cut are again quite different. I mean now that deep-mossed slow-growing land with which all travelers in the Maine woods are familiar. Here again the soil cover comes in as a reliable distinguishing mark. The mosses in this case are deep and wet, of the genus *Sphagnum* botanically speaking. German foresters know that it is a hard bed for tree seeds to start in, while its deep blanket impervious to air keeps the soil wet and otherwise damages its capacity. The moss cover of thrifty land on the other hand is not deep nor wet. The bulk of it is made up of species belonging to the genus Hypnum.

The characters of this variety of black growth seem to me oftenest and in greater part due to the drainage of the land. The nature of the rocks has something to do with it. Granite and other hard materials weather more slowly than slate, and so furnish less of both rooting and nourishment to trees. But generally the difference seems due to drainage. Water stands on the ground and aids the growth of the wet-land mosses, which assist in creating the condition in their turn. Now this is a condition in a way unfavorable to tree growth. Spruce may stand thickly in such land, but the growth of the trees is slow, and they do not reach their maximum size. Such timber, too, is especially liable to damage by winds. The trees have poor rooting, and are mainly held up by the mutual protection of their neighbors. Thinned out by cutting, the greater part of what is left is almost sure to blow down.

Management.

Numerous occurrences of this kind of timber have been mentioned in the text. A notable instance is in III R. 6, Somerset county. Here is a considerable area of heavy timber which has been and still is of comparatively small value on account of the roughness of the land and its distance from drivable water. These natural obstacles it is proposed to meet by a temporary railway to transport the lumber to driving water on the Enchanted Stream. If that is done the owners should plan, it seems to me, to clean the land. Timber they may leave will be of no account. Most of it will blow down, and if it did not, fifty years would not grow enough to pay to build a railroad to it again. The best thing that can be done is to strip the land and let it come up to a new growth. Should this prove to be largely birch, that will be no calamity. But we can count on spruce, seeing what it has done, and considering its known biological characteristics, to again some time recover the land. Let it be said, however, that fire on such a country would be a great set-back. It would burn up not merely the timber but the soil, and centuries would intervene before the land could again maintain a valuable tree growth. Demonstration of how much land of that kind is worth after fire has run over it is to be seen in the immediate vicinity. Another example of the same thing may be seen on Wassataquoik Stream, which drains the country east of Ktaadn.

A development of this kind of land remains to be mentioned, merely an intensification of its features. Rocky, clayey or moorish land which is particularly flat and therefore badly drained and wet is frequently covered with thick and spindling or well spaced and yet stunted spruce. There are some growths of spruce that are too thick, and the trees small on that account. Thinning in that case would be a benefit and followed by rapid growth. In many cases, however, that is not true. The small size of the trees is due to defects of soil and drainage which cannot be overcome. The yearly growth upon such land is very small, hardly worth considering. When the market is at hand, such growth can be cut without scruple on account of any regard for its growing capacity.

ON SCALING.

Methods of measuring round lumber in this State are so unsatisfactory—cause so much trouble in business, and in addition, as it seems to the writer, are responsible for so much loss—that it has been thought advisable to look into the matter with a view to ascertaining and recommending an equitable method.

A man coming to this subject with fresh mind and from the outside would say without question that what is wanted in a measurement of logs is a determination of their cubic contents. This being the case, and cubic feet our standard measure of capacity, what we should need for appliance is some simple apparatus to measure diameter and length, and give, in form convenient for outdoor use, the contents to be derived therefrom. In other words, the simplest and most natural measure would appear likely to be also the most satisfactory.

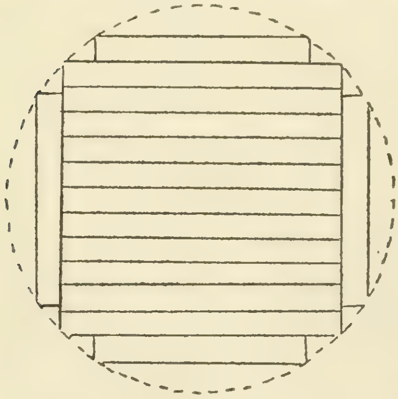
What we have in use, however, is something quite different. It is a fact that large quantities of logs are yearly bought and sold in this State without being measured at all—that is to say like no other commodity logs are sold on a mere judgment as to their amount—but when a measure is actually put on logs it is not generally the natural and simple one that an unsophisticated person would expect. It is a measure whose readings are in artificial terms. It is a measure, too, that mechanically speaking is singularly limited in its use in that, being simply a straight square stick, it is only adapted to measure a log's diameter across the end.

The Maine log rule.

No method or instrument for measuring round lumber is prescribed by the State. The log rule in general use to-day is the device of Mr. Charles T. Holland. In a little pamphlet copyrighted in 1856, and printed at Bangor in 1871, he gives the figures with which the rule was to be marked, and describes the manner of their derivation. The foot board measure is the unit of the rule. The number of board feet which a log will yield is supposed to be governed by its top diameter, and their actual number is found by plotting. Discount for imperfections, crooks and unsound wood have to be left to the judgment of the scaler. The following is taken from the pamphlet:

MAINE LOG RULE.

This rule has been prepared from full sized accurately drawn diagrams representing the end of logs of each inch in diameter from six to forty-eight inclusive. The square has first been obtained as near as practicable, for the purpose, allowing one inch for each board, with a space of one-fourth of an inch between each for saw kerf. The outside boards are reckoned in the same manner as shown in the cut on the outside; including all that will work six inches in width and upwards. In reckoning the fractional parts of a foot, all that amount to over half are reckoned as a whole foot, and all less than that are thrown away, which is the nearest average than can be made. As the rule is applied to the top end, the buyer has the advantage of the increase in size and also the saving in saw kerf when the log is sawed into larger dimensions than inch board, and there are one or more two inch plank sawed with every stock of boards.



The diagrams and the computation are the work of a civil engineer of established repute and no one acquainted with his work will doubt its perfect accuracy.

I claim for this rule that it is as perfect as it is possible for the science of mathematics to make it, and I also contend that all rules hitherto used in this State are grossly incorrect, largely overrating some logs and as far underrating others. It will be understood that there is no allowance made here for defects, that being left entirely to the judgment of the scaler. CHAS. T. HOLLAND.

The "Maine" or "Holland" rule has thus been in use many years in this State. It succeeded a variety of rules built on the same principle. At the time when it was put into use pine was the staple of the lumber cut of this State. As a rule it was large timber, and only the better parts of the tree, the clear trunk lumber, were worth taking. These trunks moreover were not driven whole. They were sawed into lengths of from twelve to twenty feet, just as the pine of the Northwest is now treated. They reached their final market for the most part in the form of inch boards.

The quantity of boards that could be cut out of a log was all the buyer wanted to know in those times, so board feet came naturally to be the term of measurement. Then since, because logs were short, the little taper they had could be left out of account, the top diameter of a log could fairly be used with its length in determining contents. This diameter could be very well measured by a straight rule. Thus for the times and circumstances, assuming the correctness of the figures, Mr. Holland furnished to the people of Maine a convenient and satisfactory measure. So far as I know it worked well, just as similar rules, Doyle's and Scribner's, work to-day in the pineries of the West and South.

The rule now inadequate.

Conditions in the lumber business, however, have now greatly changed, and several reasons can be shown why the scale rule is now unsatisfactory. In the first place, as Judge Buswell has discovered, there are irregularities in its figures, and these, inconsiderable though they may seem to be, are rendered important by the increased value of lumber. The actual results of plotting, as Judge Buswell says, should have been evened by some method of adjusting differences. Secondly, most saws nowadays waste far less than the quarter of an inch allowed. Thirdly, a large proportion of our lumber cut is now used for pulp, and the scale rule, throwing as it does a much larger percentage for waste out of small logs than large, is unfair when applied to that purpose. Slabs and waste, too, are now of value, while the rule leaves them out of account. Lastly, trees are now generally cut whole, and the rule, basing its results on length and top diameter, is utterly inadequate to their measurement. The instrument was not devised to do the work which we now call on it to do, and its employment for the purpose is directly responsible for much waste, and is a prolific source of dispute and litigation.

Every man who has ever had anything to do with lumbering has his ideas about the scale rule, and some hints about how it works have been given in the narrative portion of this report. What must be done now, is to give some concrete examples of the injustice and waste wrought by the scale rule, also some wholesale figures as to its values in relation to the actual contents of logs. For material for both these purposes, I am inbebted to the courtesy of the United States Forestry Division which has allowed me to make free use of the figures collected by myself in its employ.

First in this connection are some figures worked out by Judge Buswell in his study of the subject. His purpose was to get at the percentage of true contents which is given by the rule. He figures first the solid contents of a cylinder of given diameter, ascertains next from the rule what the scale is for a log having that diameter, and reducing the reading from board feet to cubic feet divides that figure by the solid contents. The result is the percentage of sawed lumber given by the rule of cylinders having the stated diameter.

This does not allow for taper, however. To do that, actual contents of logs must be figured. This I have ample material to do, using the Forestry Division's measures of trees before mentioned, of which for spruce in our woods I have figures on several hundred.

Percentage given by Maine log rule of contents of cylinders of same diameter.

Diam.	%
6	53.9
7	60.6
8	67.4
9	61.7
10	64.9
11	65.3
12	69.4
13	67.9
14	69.4
15	68.4
16	66.7
17	66.7
18	68.5
19	71.7
20	72.2
21	72.7
22	71.6
23	72.4
24	72.9
25	72.9
26	71.6
27	71.6
28	74.7
29	74.6
30	75.0

Taking first then logs out of the trunks of trees where there is least taper, I obtain their actual contents as given by caliper measures taken every four feet, then take the scale of the log by the rule. Logs are supposed cut in each case sixteen feet long. They are taken of all sizes which my notes give in numbers sufficient to be safely averaged from—from six to sixteen inches inclusive in top diameter. These sizes will include most of our marketed spruce.

16 foot butt logs. Percentage of cubic contents given by Maine log rule.

Diam. at top.	%
6	43.3
7	49.4
8	54.6
9	51.8
10	55.0
11	56.5
12	59.7
13	59.1
14	59.0
15	59.9
16	56.6

The results of this computation should be briefly summarized. Logs from 6 to 9 inches in top diameter, of this description and length, may be said to be given 50 per cent of their contents by the rule. Logs 12 inches and over are given 60 per cent. The meaning of this for the buyer of logs for pulp will be best seen when it is stated the other end to. A man buying logs of the smaller size gets about a fifth more actual wood per thousand of lumber paid for than if he buys the larger sizes of lumber. A minor feature in this series of figures remains to be pointed out. It is the percentage for logs of 8 inches in diameter. This figure is greater than its neighbors above and below, a relation that is more marked in the table of per cents of Judge Buswell's working earlier given. It shows, what Judge Buswell so far as I know was the first to discover, that the reading of the rule is here irregular and unjust, that logs of 8 inches diameter get a larger scale than they are entitled to. This irregularity Mr. Buswell himself, while he was keen enough to discover and utilize it, is strong in saying should be remedied.

* Percentage of cubic contents given by Maine log rule.

Di'm at top.	Length of log.	
	16ft.	30ft.
8	54.6	44.3
9	51.8	43.2
10	55.0	45.2
11	56.5	48.5

If the rule among logs of different diameters is an unfair measure for many purposes, it is no less unsatisfactory among logs of different length. A 30-foot log is the longest that can be scaled by the rule. It scales twice as much as a log half that length, and the little table herewith shows how that works in relation to cubic capacity. The relation shown in the two sets of figures is typical. The shorter a log is, the better the scale the rule gives it. The reason for this is perfectly plain. The rule is read with top diameter only, and the swell of a log from the top down is far greater proportionally in a long log than it is in a short one. All these differences render the rule unsatisfactory as a measure, liable to abuse, a source of uncertainty and dispute among business men.

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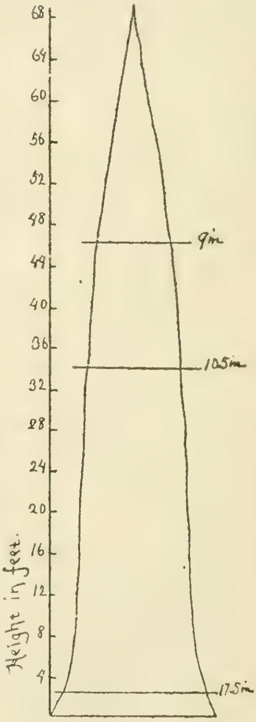
* Logs in both these cases are trunk logs—that is cut off below the limbs of the tree. Much greater differences might have been obtained by taking the 30-foot log higher in the tree.

So much for the actual scale of figures given by the rule. Bark, it should be said, is thrown out of account here in all cases. The per cents represent the proportion of the wood of a log which is given by the figures on the rule, or in other words supposed to be net lumber at the saw. What has been proved so far is the unfitness of the rule by reason of the principle of its construction to measure fairly logs that are destined for pulp or for any other use which depends simply on their cubic capacity. This fact in general, indeed, is more or less known among business men. For instance I was told by a paper manufacturer on the Androscoggin that a thousand feet of spruce by Androscoggin survey would pile up, if made up of large logs, about one and one-half cords, if of small logs one and three-fourths. That is a difference amounting to one-sixth of the smaller quantity.

What is next to come will be best understood by aid of the diagram herewith presented. This diagram shows the shape of the stem of a spruce tree, multiplied in its horizontal dimensions, from the ground to the top. The figure was drawn from caliper measurements every four feet of a tree that grew on one of the townships in the region of Moosehead lake. It is, in fact, the same tree that was referred to on page 50 of this report. The stump left by the lumbermen who cut it was two and one-half feet high, and they cut a log out of the trunk thirty-two feet long with a top diameter inside bark of 10.5 inches.



Shape of trees. Influence on scaling.

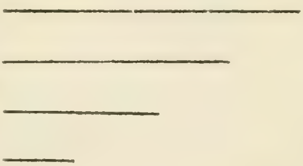
The main thing to notice in the figure of this tree is the way in which it tapers. The lowest limbs on the tree were thirty-three feet from the ground, two feet below the point where the log was topped off. Up to this point the taper of the stem is slow. In the twenty feet from the top of the log down, the increase in diameter indeed is only two inches. Above that point, however, is is seen soon to change. Twenty feet above the log-cut the stem is 5.5 inches smaller than at that point. Above forty-five feet high the tree shrinks at least one and one-half inches every four feet. And this tree is in this respect typical. We may state it as a law holding in general among our forest spruce that at about the lower limbs a taper begins which is markedly stronger than that found below. This fact has important bearing in consideration of a just method of scaling timber.

To take the simplest case first, let us take two sets of logs of the same top diameter, one set being butt logs from the trunks of small spruce, the other from the upper portion of trees of larger diameter. The little table herewith given tells the story. The figures for some small logs high up in large trees are also given. Further, to put the same facts in another form which perhaps will still more clearly bring out the point, for quantities of wood represented by the three upper of these parallel lines we get the same value from the scale rule. The actual value given by the rule, reduced to cubic feet, is given by the fourth line, the one beneath. The values denoted by these lines relate to logs 6 inches in diameter at the top. Here again we have by no means an extreme example.

Proportion of contents given by Maine log rule in butt and top logs. Logs 16 feet long.

Diam. at top.	a.	b.	c.
6	43.3	29.4	23.9
7	49.4	37.3	33.0
8	54.6	41.9	
9	51.8	42.0	
10	55.0	45.5	

(a) in butt of small trees.
(b) in lower crown of larger trees.
(c) high up in crown of large trees.



The practical effect of this peculiarity of our scale rule must be pointed out. It might be thought that it would work well, giving to knotty top logs of strong taper a sufficiently less scale so that at an even rate of stumpage their value would be approximately truly got at. As a matter of fact, however, that is not how it works. It works rather to leave those top logs to rot in the woods. Particularly is this the case where men are hauling by the thousand or cutting on stumpage permits to sell. They know that they can get no pay for such lumber at all commensurate with the expense of its handling, so that methods being as they are and strong competition in force, they must leave it or suffer loss. Thus it is that within the range of the use of our Maine rule, it is only where the owners of land cut for their own use, or where special study has devised means to counteract the natural tendency of the rule,* that any such lumber is hauled. Yet such lumber has utility either at the saw or for pulp. If eastern men doubt that, they have only to go over to the Androscoggin to see it proved. That in most of the spruce lands of the State it is not now taken, seems to me mainly due to the general use of a faulty scale rule. Some figures representing the amount of the wastes that occur in this direction will be found in the appendix.

The principle I have tried to make clear is that a log with strong taper cannot be fairly measured by taking its top diameter only. A diameter at its middle point, which a caliper measure only is adapted to take, is the only single diameter measurement that can be called representative and fair. An example will help to make that clear. Thus a top log with an upper diameter of 6 inches and 16 feet long scales by the rule 20 feet. It might have 6 cubic feet in it. Experience shows that such a log so scaled is almost always in our large forest areas left on the ground. The Blodgett rule, however, the caliper rule of New Hampshire soon to be mentioned, gives the same log a value of 40 feet, and experience teaches that scaled in this way such logs are generally taken and used. The latter figure moreover is not really an overvaluation. It simply gives a value proportioned to actual cubic contents.

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* A practice of this kind that has worked successfully in one case on the Kennebec may be of service to others. The practice in the case of long logs is to measure off 36 feet from the butt and scale that portion from the top diameter with the usual rise. Whatever is above that, no matter how short, is separately scaled.

Less scale for more lumber.

So again when, as is the usual practice in our woods, trees are not cut into several logs, but the merchantable lumber is driven whole. At this point it will be well to turn back to the figure of our sample tree lately given. The lumbermen who cut this tree were working on a stumpage permit and sold their logs at Bangor. This tree they cut off just above the lower limbs, at the lower of the two cross lines drawn. Out of a tree with a total height of almost 70 feet they took thus a log 32 feet long. Why was that? Why was that lumber that any man knows it is a shame to waste left on the ground?

There are several things that come in here, but the main cause is again in the use for measurement of the Maine scale rule. As a matter of fact those lumbermen cut that tree off just where under current methods of sealing it would scale most. If, for instance, they had cut their log 12 feet longer, at the upper cross line, they would in all probability have got less for it. And yet they would have had the expense of handling, hauling and driving 22 per cent. more timber. Of course they cut the log short under those circumstances. Who in their place would or could do otherwise? But look at the loss to the land owner whose returns might have been so much more if just methods of scaling were in vogue. Think of the loss to the community, too, which through its working men first, and later through the whole circle of its business relationships sustains this needless waste. It seems probable to me that lumber amounting to not less than $100,000 in stumpage value is yearly thrown away from just this cause.

Injustice and uncertainty.

The condition of uncertainty and confusion to which current scaling methods have brought the lumber business in some quarters is hardly to be believed without personal knowledge of the facts. Schemes have been devised to make the rule do work it was not designed to do, and they have often resulted in greater confusion. There is, for instance, the practice varying in details in different regions, that logs over a certain length shall be scaled as two pieces of equal length; then since the rule is not well adapted to measuring the diameter in the middle, in order also to save time and expense, diameter is measured only at the top, and a "rise" given for the butt log proportioned to the length or in accordance with the judgment of the scaler. In the hands of experienced and fair men this has worked well, but it does not work smoothly. Men can seldom agree in the scale of the same logs. Little differences in manipulation too strongly affect the result. Too much is left to the judgment of the scaler. To failure in either direction, knowledge or disposition, the practice lends itself with peculiar facility. Finally the attempt in some quarters has been given up and it is recognized as a fact that the judgment of a fair and experienced man is as reliable as measurement by the rule. Men say in all candor they had just as lives buy logs that way. Indeed many lots of logs are bought of which only a small proportion have been measured. It is common report, how true I cannot personally say, that of the spruce logs consumed at Bangor but a small proportion are actually measured at the final and binding scale. The rest are said to be estimated by a man standing on a boom and saying as the logs run by how many of them will make a thousand. This is a kind of measurement which we employ, and can afford to employ, on no other commodity.

It will, finally, be a striking illustration of many things that have just been said about scaling, as it might be a text for a good deal more, if we take the tree which we have been using for illustration, scale it in different ways, and see how the results compare. Scale will in each case be given full, that is to say discount for crooks and unsound wood will be left out of view.

Log as cut, 32 ft. long; contents with bark 31 cu. ft.; scaled as 2 16-ft. logs, giving butt log 1 inch rise	169 ft
Scaled as 2 16-ft. logs, giving butt log actual rise	185 ft
A 16 foot log above, that might have been taken, scales	31 ft
Log if cut 40 ft. long; contents with bark 36 cu. ft.; scaled as 2 20-ft. logs, giving butt log 2 inches rise	168 ft
Scaled as 2 20-ft. logs, giving butt log actual rise	195 ft
Scaled as 4 10-ft. logs, using actual top diameter of each	216 ft
Whole tree, sawed down at 1½ ft. from ground and taken up to 6 in. diam.; contents 43 cu. ft.; scaled in 16-ft. lengths from butt up with actual diam.	226 ft

Total contents of the tree's stem, 46 cu. ft.

What is objectionable in the Maine scale rule might be summed up as follows:

1. Its readings are irregular and not based on present methods of sawing.

2. In giving the yield of lumber at the saw, it is made by that means an unfair measure of logs destined for use as pulp or any other use which looks simply to cubic capacity.

3. It was not devised for the measurement of long logs such as now are generally cut, and cannot without change of form and extra labor be conveniently used for that purpose.

4. The attempt to use the rule to do work which it was not designed for has resulted in the building up of complicated practices differing among themselves. For this reason the scale of one region is unlike that of every other. A business man moving from one region to another would have to study the scaling methods prevailing before he could make a trade in lumber. These practices too, with the original limitations of the rule, make scaling very uncertain and unsatisfactory. Too much is left to the scaler's judgment. Negligence, incompetence and interest are given too free a chance to influence the result.

5. The actual working of the rule is such that a larger quantity of wood often scales less than a smaller amount. For this reason great quantities of lumber are left to rot in the woods. The waste of this nature amounts to a considerable percentage of our lumber cut.

Under these circumstances the establishment by the State of a just system of scaling will be a highly commendable action. It will promote the public interests, and those of individuals as well. It will be of particular help to the lumbermen themselves, those I mean who do and direct the work in the woods. These men have the hard part of the business. They take much of the risk, do the hard work, face the cold and the wet, and they get as a rule but little for it. These are the men on whom the uncertainties of scaling bear particularly hard. The proportion of their profit is often within the limits of variation in measurements by the scale rule. A new scaler may upset all their calculations and change expected profit into a loss. And when that happens it is for them a genuine disaster. These men are a part of the sinew of the country. From them largely will its next generation come. Whatever will promote their interests, whatever at any rate will help to secure to them steady and even-handed justice, is well worth the consideration of the law-makers of the State.

Principles of a satisfactory system.

A system of scaling cannot here be formulated. Some of the principles that should guide it, however, may well be mentioned. It should in the first place be simple; as few measurements as possible should be taken to get at the contents of a log. This is economical; it prevents errors also, and makes the measurement all round more satisfactory and open. Secondly, quality should be kept distinct from quantity. Behind every trade in lumber should be a recorded measurement, free from complications, of the tree's contents. Quality is another matter. If it is to be passed on by the same man well and good, but the two things should not be lumped together.

Here we get a suggestion as to the measurement of our spruce, a large and growing proportion of which is being manufactured into pulp. For the pulp mill, cubic contents is what we really want to know. Why not get that for all lumber, and consider its adaptability and yield to the saw as a matter of quality? Measure the actual cubic contents of the logs in your landing or your boom, and such of them as are to be sawed judge of, or measure again if necessary, from that point of view. Certainly that is more natural, and will when established be more satisfactory, than the reversed practice which is now in vogue.

Measurement by a caliper rule.

Neither is this suggestion without support, personal or in experience. Some of the most practical and experienced men with whom I have talked hope to see present practice torn up from the bottom and simple cubic contents substituted, to be measured with a caliper rule. The great advantage of this system is its simplicity, the certainty with which it gets at a fairly accurate result. All that is necessary is to measure length and mid diameter of a log, the figures on the rule giving the cubic contents. The ratio of board feet to cubic feet in logs of different sizes could further be had for the convenience of saw mill men.

Some will question the accuracy of this method of measurement as applied to long logs, such for instance as might be cut out of our representative tree. On this point tabulations could be presented if necessary. From these it would appear, I think, that the accuracy of the method is sufficient. Whatever the length and shape of the log, the departure of the values so gained from true figured volume is but a small per cent. No premium, at any rate, is put on timber waste.

The experience of others, however, is conclusive on this point. The practice of Europe so far as I know it is of this kind. I have myself helped measure timber in the Black Forest of Germany. Great trees there 3 feet through and 100 feet or more high, cut off away up at 8 or 10 inches diameter, would have their diameter measured only at the middle point. And lumber there too was worth three times as much per volume as at the mills of Maine.

Finally, as helping to approve the principle of the system of measurement here proposed, and perhaps in all its details furnishing us with a pattern, I will refer to the practice of the state of New Hampshire. Here an artificial cubic foot has been made by law, equal to about 1.4 of the standard cubic foot. To measure contents a caliper rule has been constructed known as the Blodgett rule. As used in practice, it gives the contents of a log from length and mid diameter, seven-eighths of an inch by the structure of the rule being thrown out for bark. The law under which this method of scaling was established is quoted below. In practice it has so far as I know worked very satisfactorily.

Public Statutes, New Hampshire. 1891. p. 358.

Chap. 128, Sec. 4. All round ship timber shall be measured according to the following rule: a stick of timber 16 inches in diameter and 12 inches in length shall constitute one cubic foot, and in the same ratio for any other size and quantity; forty feet shall constitute one ton.

Sec. 5. All round timber, the quantity of which is estimated by the thousand, shall be measured according to the following rule: a stick of timber 16 inches in diameter and 12 inches in length shall constitute one cubic foot, and the same ratio shall apply to any other size and quantity. Each cubic foot shall constitute ten feet of a thousand.

Ratio of board feet to cubic feet.

One thing under the head of scaling still remains to be dealt with. That is the ratios of board feet to cubic feet used in the earlier portions of this report. A problem was involved there somewhat difficult of solution. The settlement of it finally chosen may perhaps not be generally approved of as the best one.

It is well known that the larger a log is, the better, when a board rule is used, does it scale. So it is clearly with trees. The larger they are, the longer they are left to grow, the better they scale in proportion to their cubic contents. But how shall we measure the rate of this increase?

A partial answer to that question given by Judge Buswell, as a result of his study of the scale rule was detailed in the last Maine Forest Commissioner's Report. Saw logs, according to the usual Kennebec standard, are logs that will measure at least 8 inches at 20 feet. Such a log scales, by the Maine log rule, 55 feet. A 6 inch log of the same length scales 25 feet. Logs of the latter size are salable on the Kennebec for pulp. Judge Buswell then, having ascertained approximately the time required for a tree to grow two inches in diameter, figured out the increase in percent at compound interest, and determined on a policy of cutting governed thereby.

It took a very clear-headed man to solve so neatly and satisfactorily this highly practical problem. For the purposes of the present work, however, figures so derived do not appear to be sufficient. The growth in length is left out of account. In the larger tree, part of what is above eight inches in diameter is often used. It will be used in the future at any rate if not used now. In figures for general application, account will have to be made of it.

An example cited by Mr. Crawford from the records of the New York forest commission will throw light on this matter. In 1875 there stood in an Adirondack forest a small spruce tree ninety-seven years of age, able to yield a log six inches in diameter at the top and thirteen feet long. This Mr. Crawford scales at 13.5 feet. In the year named the larger trees were cut out around this small one, so that from then on it grew rapidly. In 1893 it was itself cut. The butt log at that time, cut at the standard length of thirteen feet, had a top diameter of ten inches. It scaled fifty-four feet. But above this two other logs were taken, each of the same length and with a top diameter of eight and six inches respectively. The logs taken from the tree scale altogether 108 feet, an increase in eighteen years of 94.5 feet or of 700 per cent.

This tree would not be cited as a typical example of spruce growth, though many trees could be chosen that have grown as much or more. It illustrates, however, the point desired, the fact that with growth the length of merchantable timber increases as well as its diameter. Measurement, however, is not always so easy as in this case. Trees do not always cut just of the standard length, and where there is no standard and scaling methods vary so much as they do in the State of Maine, it is hard to settle on a measurement that will be fair and representative. I will only state the solution which after some consideration was finally chosen.

In the first place growth all the way through was figured in cubic feet and not board feet. Reckoning in those terms was easier, and results will be more widely and longer of value. Tree volumes were given in cubic feet, the percentages of growth applied were those for increase in actual cubic contents, the resulting volume and the average yearly production were both stated in the same terms. It remained then simply to get at a converting factor, a ratio between cubic feet and board feet which should convert results into the common business term. This, as already indicated, had to be worked out for trees of different sizes.

In the records of measurement of hundreds of trees of all sizes so many times mentioned there is ample material for the purpose. Taking a sufficient number, and ascertaining first the total cubic contents of each, the stem is supposed to be used up to six inches in diameter, the stump height allowed being about two feet. The trunk is then supposed to be scaled in sixteen-foot logs beginning with the butt, the small top piece when one remains being given separately a fair valuation. On general principles the figures are then reduced sixteen and two-thirds per cent. The accompanying table gives the results. First is given for trees, seven, eight, etc., inches in breast diameter their average volume as actually found. Bark is here included. Next to that is given the scale, bark off, as just defined. The one set of figures is then divided by the other, giving thus board feet scaled for each cubic foot in the tree. This last set of figures has been evened by plotting and drawing a curve.

Breast Diameter.	Contents —cubic feet.	Scale—feet board measure.	Board feet per cubic feet.
7	7.2	13	1.8
8	9.3	25	2.6
9	12.8	42	3.2
10	17.2	65	3.6
11	21.	80	3.85
12	25.5	102	4.
13	29.2	115	4.1
14	34.3	137	4.2
15	41.	173	4.25

Probably these figures represent about the closest cutting and most liberal scaling now practiced anywhere in the State. A large share of the trees used in this tabulation were cut in the Moosehead region by men cutting on stumpage permits to sell. The scale by current methods *of the logs they actually took, including none from trees less than eleven inches in breast diameter, has been figured out. It underruns the figures of the table by nearly twenty-five per cent.

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* That is scaling logs up to 26 feet long as one stick, logs 27 to 35 feet long as two sticks allowing one inch rise for the butt, logs longer than 35 feet with two inches rise. On all there is allowed 10 per cent. discount. Seldom was 40 feet of a tree taken.

OUR FORESTS AND THE FUTURE.

Before taking up in detail the measures which seem to mean forest reform in this State, it will perhaps be well to state the attitude toward the forests and forest industry which study thus far has brought the writer to take.

Waste. What is avoidable.

First then as to waste. Here a line of distinction must be drawn. Much waste, we know, cannot be avoided. It is forced into our methods by the abundance of our resources and the cheapness of wood material in proportion to labor. Those who hold up before us the standard of European economy, without recognizing that in America it must be greatly slackened and modified, can have little comprehension of real American conditions.

On the other hand against other wastes strong condemnation can justly be made. The destruction of timber by fires has been already considerably ventilated. Not so well known, but as I believe in our Maine spruce forests greater in amount, is the destruction wrought by wind. Much of this as it occurs is again irremediable. A considerable proportion, however, as large it seems to me as of the loss caused by fire, is within the power of managers of timberland to prevent.

Then there are the wastes of actual lumbering. Trees are killed that are not utilized. Stumps are cut high and valuable lumber left in the shape of long tops to rot in the woods. A proportion of those wastes comes under the unavoidable list. With a certain distance from market, and a certain ratio of lumber value to labor cost, these goes a corresponding degree of economy which is the most that can be reached. Much, however, is not to be so excused. Much is due to mere force of habit in our lumbermen. In the old days they learnt wasteful habits, and in the slack conduct of the lumber business in some quarters they have never been compelled to learn better. Here observation in different sections of the State teaches us a great deal. We learn by that means that the form in which business is organized has much to do with it. Where the owners of timberland are at the same time its cutters, particularly if they cut to stock their own mills, there the greatest degree of economy is secured. On the other hand where the stumpage system is in vogue, where, that is, the owner of land does not cut it, but permits its cutting to another who may or may not manufacture the lumber also, there great wastes are sure to occur.

Lastly in the connection are the wastes that arise from our method of measuring lumber. If there is any excuse for longer endurance of this, if after the facts are known there is reason for hesitation in establishing by law a rational, just and uniform system of measuring lumber, that reason has not occurred to the present writer.

Next as to exhaustion of our forests. On this theme we have in recent years heard very much. Some practical men believe it. Others dispute it. What is the fact?

Exhaustion of forests.

On the general subject I cannot refrain from registering the opinion that the best indication we yet have is the judgment, evidenced in price of lumber, of business men. If official statistics and predictions are more reliable, there are at least many in the country who are unconvinced of it. How should it be otherwise indeed? Where is the volume of detail study from which alone reliable scientific conclusions can be drawn as to the resources of the country?

And if the judgment of practical men is still to count, we have, to say the least, no need to fear an impending timber famine. Prices show no tendency to panic. Great natural stores still remain, and the enterprise of American business men, exercised particularly in the development of transportation, is gradually bringing them into use.

What has Maine to expect.

Coming back to our own proper field, the timber resources of the State of Maine, a similar conservative attitude must in general be maintained. By far the greater portion of the State is covered with trees, and it is perfectly certain that it will remain so. The poor soil assures us that the greater portion of the surface of the State never will be put to agricultural use. The topography and the climate assure us that all uncared-for areas will stay tree-covered.

More definitely as to the particular problem of timber supply there are numerous things to be said. Exhaustion in one sense is a reality. Of that we have had demonstration. The pine that once was the staple of our cut of lumber is now practically gone, and none of like quality is coming on to replace it. Of spruce we know we have not to fear such complete destruction; yet partial exhaustion in this direction is known to be possible. We can strip a country of the best part of its original timber. The Kennebec, as may be seen by looking over the logs to be seen from the cars, has already yielded up the bulk of its old and heavy timber. The small rivers of Washington and Hancock counties are further along on the same road. Years ago due to lumbering and ship-building there were located here many prosperous, busy communities. Now times have greatly changed. Ship building has gone altogether. The original stock of soft wood timber has been practically used up, and the people are reduced to handling that amount of timber which the country, crippled by fire and heedless cutting, can supply by growth. This is but a fraction of the former cut and far inferior in quality, made up mostly of hemlock, fir, small spruce and second growth pine. And yet down to a very recent date the men in control of the business thought supplies were inexhaustible. About thirty years ago, for instance, a great fire raged on the East Machias river, and men let it burn without hindrance or thinking much about it because they thought however much might be destroyed they still had enough. A careful study of the history and resources of these eastern rivers would be a very instructive matter.

Exhaustion of the original stock is a reality and it is certain that in time our larger rivers will reach it. This is, however, in itself nothing to be deprecated, nothing even to lament. That timber standing there we believe we have a right to, a right to use it with all the other resources and capabilities of the land. What use indeed has it to stand there? An acre of virgin timber produces nothing, because as much yearly rots as grows. It is only when it has been cut through, when the mature timber has been taken out, that the yearly production begins to store up. This indiscriminate prejudice against cutting, consideration must remove. It is only by means of the ax that forest land can provide us with the most evident of its benefits, useful wood material.

When the original stock of timber is gone, then we shall have to depend on growth. That is a condition that is sure to come if our people thrive and multiply and fill up the country. It is not a regrettable condition if fairly met. It is the normal condition of old countries. Within our own State in most quarters it is gradually coming in force. In some regions indeed it has long been here. Southwestern Maine for instance is doing a considerable business on lumber which is entirely the product of recent growth, and the business is but the more settled and regular on account of the character of its supply.

Our great remaining stocks.

In recognizing, however, that exhaustion of the original stock is a possibility, that it is sure indeed at some time to come, we must not neglect to carefully limit it in accordance with the facts of this particular case. Exhaustion as it may now be spoken of in connection with the great forests areas of Maine—I mean those bodies of rough poor land destined always to be forest, which make up a half to two-thirds of the area of the State—is not exhaustion of wood material. It is not even exhaustion of all timber. It is merely exhaustion of some particular qualities and kinds. The shortage that need be looked forward to in any portion of these forests to-day is that of spruce only, and while that is a serious matter, while spruce formed on these areas the great bulk of the coniferous timber, nevertheless just as the former generation did with pine, so now we shall gradually learn the extent and value of our other resources. These cannot be entered into in detail. Fir, cedar and hemlock have always been classed as inferior lumber, and in many localities and conditions of business been passed entirely by. While neither of these items amounts to very much in comparison with spruce, yet in the aggregate they will appreciably swell the returns from our forest lands.

Our great natural stock of hard woods, however, is the main thing. The disadvantages which hold of these as compared with our soft woods in regard to transportation and waste in cutting are well understood. Railroad lumbering, however, will largely meet the one, and new developments of industry possibly will surmount the other. The small demand too for such lumber must sometime mend. Our own people will not always go to the most distant countries for their hard woods. Fashion indeed may sometime work our way. It is said that the fashion for black walnut a few years ago, which all of us remember and most of us helped to feed, was created by lumber dealers who kept it up as long as there was timber to supply it. Who will say that our own birch and maple are incapable of the same kind of manipulation?

Outlook for spruce.

I must repeat that I am not speaking of the wooded land along the railways and about towns, but of the great permanent forest areas of the State. On these lands it is only in connection with spruce that exhaustion need to be looked forward to, and for spruce indeed only in some regions or in certain sizes and qualities of timber. The districts reported on in the body of this work are those where the question is most critical, chosen for that very reason. There the situation can hardly be called a dark one. On the other large rivers the outlook is no doubt much clearer. The St. John still has large stores of virgin timber. The upper waters of the Penobscot have been only very lightly cut. Men have not yet begun to sum up their resources.

Taking the State as a whole, I doubt if the yearly production of spruce is yet overcut. Assuming the amount of the yearly cut at 600 millions board measure, that amounts only to 30 feet per acre on the gross area of the State, perhaps 60 feet on what is actually spruce-bearing land. These general figures are very instructive. By the side of what scientific forestry could do with the land, these amounts are utterly insignificant. To one like the writer who believes that mere care in lumbering—stopping of the needless wastes that occur, and cutting with some reference to wind destruction and the future production of the country—would both piece out our resources considerably and multiply the volume of future growth, these figures are very encouraging. With things going on as they are the State can long maintain the present volume of the spruce cut. The production of the land we have it in our power to increase whenever we find it necessary to do so.

The paper business.

A subordinate matter here, and yet one that is of prime importance, I wish here briefly to treat of. That is the pulp and paper business. This is one of the most valuable industries that the State has. It is a substantial and lasting thing. Its worst possible enemy seems to be itself, acting in the way of overstocking the trade, increasing production beyond a natural and wholesome demand. Spruce is the staple of the raw material of the paper mills. Their prosperity seems bound up in its abundant and continued supply.

Now while there seems to be nowhere a cause for immediate fear in this respect as long as the pulp and paper mills can command the output of the land, there does seem to be the feeling in some quarters that the upper limit for price of wood has been nearly reached. I have in mind an Androscoggin manufacturer who made the statement that in his judgment the advance in price of pulp wood by one dollar per thousand could not be stood by the business—that the mills would have to go out of business or find other sources of supply.

What there may be outside of the State and its forests that may be available for the supply of Maine paper mills I have no means of knowing. What there is within those limits adequate to the stocking of a great industry seems, however, pretty clear. There is first our stock of hard woods. Any manufacture which would employ wood of this kind, using especially the cull and waste of our probable future lumbering operations, would have an almost limitless source of supply. I do not now mean poplar, which was the first wood to be used for paper manufacture in the State. Our resources of that nature I do not believe are sufficient to maintain an industry of great volume. I refer to the staple old-growth hard woods of the State which have not so far been considered available for any such purpose.

There is another resource, however, to which we might in case of emergency turn. It is in the direction of pine. Pine, those who have tried it say, has a good fibre. What has kept it out of use till the present is the large amount of pitch in the wood which increases cost of reduction. Now if through new methods of manufacture reduction could be cheapened, or if our mills by a scarcity of spruce should ever be driven to seek other sources of supply, we could cover the whole southwestern portion of the State over with this species. Pine is almost a weed in that section now. It propagates freely, and grows often in thick groves of great producing power. The production of these could be vastly increased by a little simple manipulation in accordance with scientific forestry principles. Study in this direction by the State, even in advance of any pointed demand for it, would be a very promising thing.

The prospect hopeful.

The feeling then which study of the forests of the State thus far has induced is a thoroughly hopeful one. The volume of business based on lumber has room for many years yet to grow. Shrinkage in some regions and lines of business will doubtless be largely offset by developments in new directions and by the manufacture of raw material into forms that require more labor. In general, we may feel hopeful, feel that we may use freely the resources stored up on the land.

What can the State do?

The things that need correction, too, it seems that in most cases enlightened self-interest can be depended on in time without legal regulation to correct. Not that there is nothing for the State to do. Self-interest is not now always enlightened, and the State can save the cost of the work hundreds of times over by simply spreading effectively pertinent information. For instance, to teach to-day in one section of the State the economies arrived at in others would be an immensely paying matter. The State moreover can study questions in a way that individuals cannot afford to do. It can study timber supply in a broader way. It can get at the fundamental facts, get at them once for all, and put them in the possession of every man who can use them.

Particularly in the new development that seems likely to come upon us, the handling of forest land with real knowledge and forethought, should the State direct and lead. The actual practice of the matter must be left to private hands, for the State has no timberland worth practicing on. The State, however, can encourage and aid in the matter. There are great established principles relating to trees and their growth which our people may well be taught. There are bodies of information collateral to correct forest management which scientific men only, not men of business, are equipped to obtain. There are needful things which one man cannot do because they cost too much in proportion to his individual interest in the matter, while for the community to do them is a highly paying thing. It looks as if a revolution were impending, a development in methods of handling forest land which means much to the business prosperity of the State. The State can by its support and countenance mightily forward it.

Here again I have in mind mainly the spruce in those great areas of permanent forest commonly called "the woods of Maine." In the discussion of better cutting for these lands in the body of this report, great emphasis was laid on one idea—the value of conservative cutting, of leaving young timber on the land to grow. In fact, except for wind destruction, very little in the connection was said about anything else. This it was thought would best meet the needs of the situation, best answer the questions in the minds of practical men. These questions, relating to the immediate management of timberland, had first to be answered.

To follow that lead, however, is not for this work enough. There are ways of viewing the forest which the people of this State have not arrived at, ways of handling forest land of which our lumbermen have no idea. The idea just stated furnishes us with an illustration. With lumbermen this principle of conservative cutting seems to embrace the whole matter of forest economy. "Leave the young timber to grow," is a formula that has long passed among us as containing the sum and substance of right forest management.

What is Forestry?

How weak this formula is face to face with the real facts of the woods, readers of this report have often seen pointed out. Many, probably, were already aware of its weakness. How puerile it is in comparison with the possibilities of the case, in comparison with the achievements of genuine forestry, only those who have given the matter study can know. One question will show the inadequacy of the formula—where are you going to get the young stuff to let grow?

In putting forth what I wish in this direction to Maine readers I shall have to begin at the beginning, shall have to take them to a new standpoint from which to view the forest. I have not, indeed, to point out the place of the forest in human history, the manifold ways in which it has influenced the health, the prosperity and the permanence of nations and races, valuable in its place as that would be. Most of these matters make no pressing call on us. Our agriculture and climate can hardly as yet be affected by our lumbering; the flow of our rivers has not been so seriously affected at any rate that a pointed demand has come for its investigation. Forestry as it comes now to us is the production of useful wood material. In this direction, however, we have everything to learn. The conditions of tree growth, the means of producing the most and the best timber, the conditions favorable to the germination of tree seeds and the growth of young plants, tree diseases and enemies—all these things are left out of our sight. We do not even know that there is anything there to learn.*

Forestry in Germany.

It is my purpose here to try to give some little idea of German forestry. Germany is an old country. Centuries ago what we might call its virgin timber was exhausted, and the country found itself with a dense population dependent on a limited area of land to supply its needs for wood material. What should they do? Should they stint their use in this direction to a niggardly amount? Should they exploit new territory and call on the stocks of newer countries for their supply? They did neither of these things. They went to work rather on their own soil to develop fully the resources and capabilities of their own land. The states and the nobles supported the work. Scientists labored and managers experimented. Forest schools were established to spread through the land the knowledge of what had been gained. Finally they piled up a mass of exact information about trees and everything related to their life, and established a system of forest management based thereon, that is one of the finest monuments of the thoroughness, the conservatism and the patience of the German race. And today the forest stands as one of the prime objects of the people's regard, a source of health, wealth and national independence.

This report is concluded after several months' study on the ground of the forests of South Germany. As illustrations of what scientific forestry can do I wish to tell of a few representative facts that came under my own observation.

Product in timber and money.

The first forest of which I gained any knowledge was the property of the city of Freudenstadt in Württemburg. I remember thinking as I rode up to the place by rail and found it a city of 6,000 inhabitants, that it wouldn't do for a man like myself, who wished to see nothing but woods from morning till night to live in the city. I would get off into the woods themselves and live. How great was my mistake! The forest was all about us. In five minutes' walk from the center of the city one could step into such fine woods as cannot be found in the whole State of Maine. Spruce and fir trees two to three feet through and all the way up to 130 feet high stood on the ground as thickly as they could stand. There were acres there that would cut more than 100,000 M. The previous summer I had cruised all through the spruce lands of the Kennebec, and here on single square miles was more timber than on whole townships on that river. And the best of it was that this was no new or exceptional thing. The whole area of the forest was doing it. If it hadn't old timber it did have young, which is quite as essential to the result. They were growing that timber right along because they knew how to do it and because they were patient enough to wait for results.

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* It is worth while, perhaps, to point readers to the best available sources of information. Of these, the publications of the Forestry Division of the United States Department of Agriculture come first. They are largely contained in the reports of the Department. Most can be had free on application. The American Forestry Association distributes literature to its members, to whose number additions are very welcome. The secretary of the Association is Mr. F. H. Newell, United States Geological Survey, Washington, D. C. The best manual of European forestry in the English language is a series of volumes published in London called Schlich's Manual of Forestry.

The financial returns from this forest will be of interest. The yearly net revenue derived from its 5,950 acres had amounted in the last few years to from $20,000 to $25,000. The yearly yield of wood had been 106 cubic feet per acre. The revenue paid all the municipal expenses of a city of 6,000 people, relieving the citizens from local taxation and paying a bonus to each voter besides.

Baden Baden is another good illustration. The city owns 10,000 acres of forest land in its immediate vicinity kept under the best of management, just about the equivalent of half a township of our Maine timberland and in much the same kind of trees. The yearly net revenue from this tract as an average from 1881 to 1891 was nearly $3.50 per acre. That is about the total valuation, timber, land and all, of a pretty good Maine township. A yearly net income of $35,000 has here, it can readily be understood, a significance in connection with municipal expenses.

These two instances are by no means exceptional. The Black Forest in which both these tracts are included is a region of high and rough land about a million acres in extent partly in Baden and partly in Württemburg. It is well cut up with railroads and turnpikes; it has towns and villages scattered all through it, but much the greater portion of its area is covered with trees. It is divided in ownership between the states, cities and towns, and private individuals, of which the publicly owned forests are uniformly well managed. The State forests throughout this district yield a net yearly revenue of $2.50 per acre. Tracts of unusual productiveness have yielded ten dollars. The best feature of the situation is the certainty and regularity of the supply. The management is splendid in its conservatism. Timber is never cut till it is ripe. Managers take a pride in never making a false show by overcutting. The yearly growth on these forest areas is closely known. Mills and markets have adjusted themselves to their output, and business in consequence is regular and certain.

In speaking of these results of German forestry we must not mistake the conditions to which they are in part due. German forest land in the first place is superior to ours. The soil is deeper and better as a rule because the country was never glaciated in any such way. Some of their tree species moreover are faster growers than our own, though they have nothing equal to the American white pine. Then wood material in German forests is worth much more than in our woods because it is close to a dense population which needs it. German forest management, however, is in itself a noble achievement. Without it, favorable natural conditions would be of little avail. By its means, Germany devoting a third of its territory permanently to forest—that third which is of smallest value for agricultural and commercial use—has been able not only to supply all her own demands for most kinds of wood material, but to furnish large amounts to less provident neighbors.

With these facts in mind as to the results of German forest management, the way is perhaps prepared for a statement of how they have been attained. Here we must be extremely brief. I propose as that bit of German forestry which seems to have most help in it for us in studying how to make the most of the woods of Maine to give in outline the history of a stand of spruce and fir in the Black Forest as it works out under the guiding hand of an Oberförster of the Baden State.*

History of a stand of timber.

First of all how does it start? How do the young trees come there? Most readers probably will think they are planted, but such is not the case. The man who has a big bill for nurseries and planting in his accounts is marked as a poor manager, and another may be found to take his place. No. It is rather by understanding the conditions which seeds require to germinate and young trees to thrive in, and making use of this knowledge in clearing off the old crop, that the young stand is founded. Let us, however, omit this for the present, and taking the young stand when it first has possession of the ground, trace through its history.

A 20-year-old stand of spruce and fir in the Black Forest looks like one of our thickets that we say is as thick as the hair on a dog's back. The little trees stand closely together, their foliage is high up, and the limbs on the lower trunk killed off. Many of them by force of competition die every year and when big enough the dead ones are taken out for fuel. And this dense condition is desired and promoted. The unbroken cover of leaves keeps the soil moist in summer so that growth is more rapid than it would otherwise be; the dense crowding cleans the lower trunk of limbs so that the heart lumber of the mature tree will be nearly clear. The trees on an acre of German forest are of approximately the same age. Experience has shown that more lumber and better lumber in the long run can be grown in that way than if trees of all sizes are kept on the ground at the same time.

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* Scientific readers must not hold me to strict accuracy here.

Such is the condition of things up to forty years of age. The young stand is practically allowed to take care of itself, and this it does to entirely good advantage.

At forty years of age, however, at which time the young trees might be 4 to 8 inches in diameter and 50 feet high, a strong thinning is made. Poor and deformed trees are taken out, those that are diseased as well, and such also as are overcrowded and seem destined to an early death. By this means the stand is much improved. Every tree left standing is one that is straight and good, and it has a good chance to grow. The stand by this treatment may be left pretty open in places, but in the next few years it closes up again. The trees stand as thickly on the ground as they can stand. The dense foliage shields the soil from drying out, and prevents the encroachment of bothersome weeds. The density of a middle-aged stand in a German forest, the completeness with which it occupies the ground, is something hardly to be conceived till one sees it. Second growth pine groves are all we have in this country that approaches it. The shade of the foliage is so dense and complete that not a young tree or bush will be seen for rods. All that covers the soil is a fine, even coating of moss.

So the thing stands for forty years more. Only the trees that are crowded out are removed from the ground. These have a value to sell but none to grow. Most of them go into the manufacture of paper.

At eighty or one hundred years of age, however, another condition of things begins. Spruce and fir at this age will no longer stand densely together. They open of their own accord. Through blowdown or disease, also, little openings in the cover occur, and under these openings, where the sunlight gets down to the ground, a strange thing happens. Little seedlings, which up to this time may have been absolutely lacking, though the ground was showered with seed, begin to appear on the ground. Sometimes there is a perfect mat of them, and the forest manager, remembering that the time is not far distant now when his timber will be mature, when he will have to cut it and will want to replace it with another of the same kind, welcomes their appearance and cares for their welfare. As they grow larger and require more light and air, he opens up the old stand around them. With that, too, the patch of young trees spreads. More thinning out assists it; different regions of thinning run into one another. Finally the whole area of the stand has been lighted up, young trees have followed the favoring treatment and a dense crop of them covers nearly every square rod of the ground. Much of the old stand has in the mean time been reaped. What remains to be done is simply to clear off the balance with due regard for the welfare of the succeeding stand. By these measures and on these principles the land, in the course of 120 years, handled, of course, meanwhile by many individual managers, but always with regard for its productiveness in the long run, has produced a magnificent crop of timber, has yielded in the thinnings material much more than paying for the labor of its cutting and it has afforded steady labor at about the rate of one man per 100 acres to four generations of men. During the last thirty or forty years of that time, simply by gradual removal of the crop and care for the young growth which succeeds correct handling of the conditions of light and soil, a new crop has been started ready to carry on the same process in its turn.

Application to Maine conditions.

How much of the German practice may be adopted here to advantage, how much of it is possible under our business conditions, can only be told after trial. Whatever we do adopt will be gradually taken up. Many of the measures that are recommended from that source are the same that have been suggested to us already by the facts of our own woods.

Something we must take, however, from the general attitude of the German people to the forest. The facts of the situation, indeed, will compel us. The forest will have to be regarded as a field rather than a mine. Having attained that, we shall have further to learn conservatism and patience. Patience is an essential in successful forest management. Trees grow but slowly to a mature condition. If they are cut before they are fit, the best results, the greatest aggregate returns, cannot be reaped.

Where shall we begin?

That brings us to the inquiry where will forestry with us begin? Where are the interests of parties so related to one another and to the land that self interest prompts to a conservative treatment? Here the observations recorded in the body of this report help us. It is where the cutter of land is also its owner, and has therefore, an interest in its future productiveness and value. That interest heightens, however, when the chief investment of the owner is not in land, but in mills which require the product of the land for their supply. It is our expensive plants for pulp and paper manufacture dependent for their raw material of spruce wood on the output of restricted districts, that will furnish motive for the introduction of productive forestry into the woods of Maine. Among the different regions of the State, it is on the Androscoggin where most favorable conditions subsist. There much of the land is held by the owners of costly mills. Natural conditions too are there most favorable. The possibilities are greater. The natural stand of spruce is heavier than elsewhere; the possible production of the land is more considerable.

Here, it will be seen, we gain a view of the pulp and paper industry quite at variance with that entertained generally by our people. That it is the right view, *a priori* considerations and the actual facts of the case as well leave little room to doubt. The paper mill man with his costly plant is the man most interested in steady spruce supply. As a matter of fact he is the man who is most pointedly considering it.

There are many things in the German system of forest management which we certainly cannot adopt. Thus purely cultural operations such as planting, trimming, and thinning except in well grown stands, will in our great forest areas have to go by the board. They cost too much in proportion to present wood values. Neither can we cut through our lands every four or five years as is there often done. We shall have to take more lumber at a cut to pay for the costs of the operation. Neither shall we, at first at any rate, grow spruce in even-aged stands. First trials in forest management should have the virgin woods to start with, not be confronted at the start with the re-stocking of valueless land. Now in the normal virgin forest of spruce there are trees of every size and age, down to those standing but a few feet or a few inches above the ground. These trees have cost many years of growth, and to clean off completely the old stand and aim at a full regeneration would be to throw away the time which those trees represent. Such a course postpones to a hundred years the time at which another harvest may be expected. So far ahead as that, individuals and business corporations cannot, in the changing business conditions of America, be fairly expected to look.

Main principle of management here.

On most sites then the first principle of forest management as it must come here is that principle so often referred to as being already in the minds of our practical men—sparing the small trees. This policy is rendered all the more desirable by the fact that has often been pointed out in the course of this work, the vitality of spruce under shade, its ability to thicken up and grow after long and severe suppression. This policy as often indicated in this work will have to be applied with discrimination. The problem of wind throw will be a most troublesome one. The man who has to decide whether timber can be safely left, or whether if left it would merely be condemned to blow down, will have set him oftentimes a very difficult problem

One great object of conservative forest management, however, will be the preservation of the small trees. With this in view many changes in our present lumbering methods will doubtless in time be made. In some directions the detail of the German practice may help us. Thus the Germans avoid cutting in the coldest weather when wood is brittle. On the other hand they like to cut when there is deep snow. That saves the little trees from destruction in felling.

A cardinal principle of the German practice, having value in this as well as in other connections, is never to clear off the whole or the bulk of a stand at any one time. This treatment greatly helps the young trees. Comparatively few are killed when but a portion of the overgrowth is taken, and injuries received they have opportunity to repair. Where a whole stand is cleared off at once little in the way of young growth will survive it.

Probable changes in methods.

How far we may be able to follow the example set us it is impossible without trial to say. Perhaps it will be possible in the not distant future to leave half the merchantable timber in a virgin stand for further growth. Such a course would ensure a great volume growth on the land; it would allow each tree to be kept till it reaches its finest development; it would help to maintain the proportion of spruce seed supply needed to keep possession of the land. In the discussions in the body of this work it was taken for granted that such self-denial of present profit on the part of business men could not now be expected. Encouragement to think that it may soon be considered as practicable from a business point of view is given by the fact that Mr. Crawford in the quotations later given proposes and advocates it.

Transportation.

One great matter that we shall have to thoroughly consider is that of transportation. Some phases of it have importance in the present connection. The Germans care so studiously for young trees that horses are seldom taken into the forest, but timber is moved out to the roads by hand. This we cannot do. It costs too much in our conditions. Their idea, however, we certainly can with advantage apply. Yarding with one horse it seems should largely replace yarding with two. When logs are to be used for paper and can in consequence be cut into the shortest lengths desired, there is no reason apparently why this change cannot be made. The saving it would cause in young growth certainly would be great.

Change in our ways of building main roads will certainly also come. If we are to cut systematically over land every fifteen or twenty years there is good reason for the laying out of well-planned, permanent road systems. A better road could then be built than now, more on the ground and less dependent on snow. The timber in succeeding cuts would come out on the same lines. No new cutting would be required except to bush out the roads. Such road systems must come when we get to handling land for steady returns. It not only helps the young growth, but in the conditions named will be a measure of simple financial economy.

It seems certain further that railway lumbering is likely to greatly increase in this State. This will certainly introduce economy in the utilization of timber. Perhaps it will also help to bring about the handling of land from the long-run point of view. For information on this head the quotation from Mr. Crawford is referred to.

Forestry and labor.

Finally it must be noted that in the future development the personnel will be important. Under the new regime the office of the head man in a lumber operation will be important. Aside from his business qualifications, he will have to be a man of disposition and capacity to study and choose among trees. Simple setting of a size limit which common workmen are trusted to carry out is not enough. That does not get the most out of the material, nor does it sufficiently regard the future. Each piece of ground must be dealt with by itself. The trees to be cut must be marked, and their taking out in the proper manner secured. Many of the men now engaged in lumbering are capable of doing that when once they get the idea. They plan now to the best possible advantage their road lines and the felling of their timber. The same good judgment will be shown in this other direction when there is any call for its exercise. The most difficult problem which these men will have to settle is that of protection from wind throw. European practice here will not much serve us. We have got to work on a big scale. The questions that hang about this subject—when can timber be left to stand with confidence that it will not blow down, and how shall we fix things to get out the blown timber we are sure to have, are the most delicate problems the pioneers of the new movement will have to settle.

The common workmen themselves, too, must not be left out of consideration. When a crew of tramps and criminals is taken into the woods nothing can be expected but wasteful, irresponsible labor. With poor men the best output from the forest never can be obtained. On the other hand the introduction of practical forestry means very much to labor.

In Germany the workmen in the forests are trained, almost skilled, laborers. They work all their lives at their business; they are well paid as labor goes in that country; living with their families in the forest, they are put in no such social conditions as are the men in our woods. The German forest laborer is a steady, well-conditioned, contented man, who takes a pride in the forest in which he works.

We can expect no revolution in our own arrangement of things. Doubtless the same class of men will continue to do the work of our woods. Neither does there seem to be from the point of view of the new movement any necessity for radical change. A large share of our present woodsmen are capable of fitting into the new conditions if they are only rightly handled. Steady employment, fair and certain pay, instruction and supervision in whatever is new in the work required will in a few years greatly change the habits of our careless and wasteful choppers.

Mr. Crawford on growth and reform.

Now as throwing light on several of the questions that have been dealt with, as containing besides the views of a practical and experienced as well as a progressive man, I will print some extracts from correspondence with Mr. George T. Crawford. Mr. Crawford's estimates of growth seem to be, conditions considered, in substantial harmony with the results of this work. What he says about reform in lumbering methods should have much more weight as to actual practicability than anything that could be said by the present writer.

The first extract, from a letter of Mr. Crawford dated at Boston, July 6, 1895 is as follows:

The question of the reproduction of spruce by growth in New England and the Provinces is a very difficult one to settle on account of the various conditions found. The principle estimates of growth that I have made are in the forests of Nova Scotia and New Hampshire. In the former the original growth was quite dense, the conditions of soil and climate very favorable, and the first cutting called for no trees less than eleven inches in diameter at the small end to be taken. This method of cutting necessarily leaves standing more trees in number to grow than were taken. Under these conditions, I have estimated that the annual growth might be 200 feet board measure per acre. The increase will be greater the tenth year than the first, and will be in an arithmetical ratio, but in ten years there will be an increase of 2,000 feet per acre. But this depends largely on the density of the original stand and the number of trees left after the first cutting.

In connection with a New Hampshire forest of 50,000 acres where the original stand was 8,000 ft. board measure per acre, I have estimated that should 4,000 be cut leaving 4,000 to grow (and, if carefully cut, the growing trees must be much greater in number than those taken) barring windfalls and fires, the annual growth must be at least four per cent on the 4,000 left, compounded. That is 160 feet the first year and so on. I know nothing of the spruce forests of Maine from personal examination, except a slight examination in the Androscoggin valley, in which are some very fine stands, but I have seen nothing there equal to the lands in the Ammonoosuc valley and those south of the White Mountains. In these districts it is difficult to find any large tract that has been cut with a view to perpetuate the growth. No such system will be generally adopted until it is too late.

The following, written to Mr. Crawford, may be worth printing for its own sake as well as to introduce Mr. Crawford's ideas:

Your letter suggests an important topic. You speak of the practicability of cutting a stand of timber at several cuttings instead of one. I would like to know how much more it will cost to lumber in that way—like to have you discuss all the difficulties and changes that will arise in adopting such a method of lumbering. Suppose, for instance, you have a stand of 10,000 feet and cut 5,000 at the first cutting. Then in ten to twenty years come in for another cut and so on. We understand the advantage in the added growth—but how much greater will the expense be?

Will it not be better to employ smaller crews than now, and what about the lasting powers of camp buildings? Would it be at all practicable to adopt the German system of settled, "all the year round" workmen on a township? That would enable you to train men to the improved method better. I have thought of this organization when cutting lightly in this way on a considerable district; you could cut in summer and fall, using small crews and having lightly built camps where convenient over the district. Hauling to be done by the same crews in winter and the main camp to be at the landing. Some such arrangement might prove to be necessary if, instead of stripping land, you are cutting it lightly for growth.

There is, too, another important question, that of roads. The Germans have fine permanent road systems, and when we change the purpose of our cutting, we shall have to adopt something of the same kind. That is, if we are going over land every twenty years or oftener we will want to plan our main road lines from the beginning, and build good roads on them. Isn't this necessary and practicable? Another reason has also appealed to me for this change. As we change our system of cutting we shall doubtless have damage from wind, a considerable amount, which in the coming values of lumber we ought to get at. A good and permanent road would allow this to be brought out on the light snows without much special swamping or road-making.

I make these suggestions to you hoping that they will elicit valuable ideas in return. I should be glad of a statement from you on the matter.

It is possible you do not quite see all that is involved in successfully handling land for continued growth. You say cut a part only of the stand at any time, leaving the smaller trees to grow. That takes for granted a steady supply of young trees—they should be there of all ages from the smallest up, and in sufficient numbers. If spruce does not so come on, the land is gradually losing its stock—being turned over to other kinds of growth. Now cutting ought to have that particularly in view, and prepare the conditions for the coming on of young spruce.* Those conditions we do not fully understand, and with the variety of our species their control is much harder than the similar problem in Europe. Our dwarf maples particularly are a great bugbear.

My point here is simply that cutting out the big trees is hardly enough. It should be done with reference to the young, clear down to the smallest sizes, otherwise the stock of spruce will in many cases begin to run out.

Mr. Crawford's reply to that communication was as follows:

I fully agree with you in the belief that the time has come when the prevailing system of logging should be radically changed. Too much is trusted to ignorant choppers who have no other interest than to get in their time. If the timberland owner, whether he be a lumberman or pulp mill owner, could be educated up to the fact that the prevailing method of cutting is not economy, it would be of great benefit to the country.

In the Androscoggin district there is now more spruce used for pulp than for lumber, and the pulp mills will increase their output until in a very short time the saw mills must shut down. Now careful and exhaustive trials made by one of the largest pulp and paper mills on the Connecticut river show that a cord of wood peeled in the woods in the summer time will make 450 pounds more pulp than a cord of wood measured with the bark on and peeled on a barking machine in the mill. This difference, with pulp at $12.00 per ton, shows $2.70 per cord in favor of peeling in the woods. It will not do to drive peeled wood down the rivers on account of gravel getting into the cracks. Consequently it must be railed, and the time is soon coming when all the pulp mills on the Androscoggin will be supplied with their stock by rail. Experience has shown that the dangers and expense of driving and the cost of pulling out of the river will go a long way towards building railroads to the trees, thereby lessening the cost of logging. Peeled wood can be logged, loaded on cars and hauled to the mills for enough less money to pay for the cost of peeling. If you will watch the operations of a barking machine, you will readily see where the 450 pounds of pulp goes to. With this system of railroads, the sawing down, peeling, yarding to small yards, sawing into four foot logs, and piled ready for hauling to the track, and a large part of it yarded directly to the track, could all be done in the summer when the men can live in tents, thereby saving a large part of the cost of log camps. The winter's operations would be confined to hauling, when the men and teams could live at the track, in cheap frame shanties covered with tarred paper.

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* A subject is touched here, as it has been touched several times before in this report, that has not been elucidated for the good reason that it could not be. The exact conditions required for the germination and early growth of spruce, compared as they must be with those of competing species, have not so far as I know been studied by anyone. They should be studied, however. When the facts are in hand it is possible that we shall be able to make use of them in the handling of timberland.

In this system of railroad logging as above indicated, I would work small crews, say about twenty men, for whom one man could cook, with a foreman who has some knowledge of true forestry. If something like this method could be adopted, I think the cost of operating could be reduced to the minimum, even if done with the idea of reaping the maximum profit in a reproduction by growth.

No arbitrary rule can be adopted as to the minimum diameter at which trees should be taken from a virgin forest. The man who has charge of the cutting should study the conditions of the growth in which he is at work.

Here the case must be rested. How much we can actually improve our lumbering methods remains to be seen. How much of European forest practice can be transplanted here in a new country and among democratic institutions only trial can tell. Changes must be slow and well considered, proceeding in accordance with the circumstances of each case. How much these vary within the limits of the State it is hard to believe. It is true for some sections that the ideas that have been lately discussed are hardly at all applicable. Those sections are not far enough along to receive it. Merely to stop needless wastes that occur, catching up in the direction of simple economy with the standard of other sections, is all that for years can be expected. Elsewhere the situation is different. Men have come to value the forest higher, to use it with considerable economy and some foresight. Fixed investments of large size are dependent on the forests.

Here it seems as if the way were opened for genuine forestry. This indeed we cannot copy after the German model—the lines of our practice must be of our own devising. The purpose of it, however, must be the same, the obtaining of a steady yield of valuable wood from land; the principles of it cannot be different because both alike must look for guidance to reason and nature.

How much we may be able to reap from land under our business conditions, only trial again can tell. It seems, however, judging from the facts embodied in this report, that carefully studied cutting, cutting that is economical and has a distinct view to future growth, a system, however, that is practicable from a business point of view, might double or treble the growth that can now be expected from the country. That indeed would be a striking advance. It would mean much to the future prosperity of the State. One accomplished success in that line, one wild township successfully handled for steady yield, would be a valuable object lesson not alone to the State of Maine, but to the whole country whose areas of forest land must some time come to be handled on the same principle.

Here this long labor must be brought to a close. That is done with a knowledge of its imperfections, a strong sense of its limitation in comparison with what might be. Nature calls to her study so invitingly, the possibilities so open in every direction, the promise of usefulness is so great to one who has looked over this field, that one work ended can be satisfactorily viewed only as a stepping stone to further results, of greater scope and value. To the forest commissioner of the State, with thanks for the opportunity to do this work, with thanks also for encouragement and co-operation during its execution, the results are respectfully submitted.

AUSTIN CARY.

CONCLUSION OF MR. OAK.

There seems to be no necessity of remarking to the reader of Mr. Cary's report that the field of study he has opened and outlined is full of most important facts and problems that directly concern our commercial interests.

The subject is so fruitful with ideas for practical investigation that it seems difficult to select which ones to give greatest prominence.

To those who read and study the result of his labors, I think the question will naturally arise, to what extent is it advisable to search further for the facts in order to solve the problems?

In this connection I wish to say that only by means of a much larger appropriation can we continue the work.

No man in the State has had the opportunities for studying the subject that Mr. Cary has enjoyed and no man, in my judgment, is so well qualified to continue the work ; but unless we have larger means to secure his further services, we shall lose the benefit of his experience and be obliged to wait some years until greater interest is aroused and some other man has reached his standard before the work can progress.

In other words the department will be obliged to stop all work of investigation regarding forestry matters unless larger means are provided.

Referring to his report I wish to call attention to what he finds the condition of lands said to be stripped of lumber.

It is rare indeed that it has ever occurred, yet very many think so, and their belief has given rise to the erroneous idea that it is possible to take off a crop of lumber every few years from comparatively worthless land,—a condition that is clearly impossible.

Furthermore this loose cutting has created a false notion in the minds of many that our lumber supply is inexhaustable —that annual growth is much more rapid than it actually is, in other words that we can follow the policy heretofore pursued in cutting our forests with perfect safety.

While I do not care to pose as an alarmist, I have no hesitation in saying that the idea is all wrong. We think it fully demonstrated that it is possible to exhaust our forest supply of spruce by present methods in the course of the next century at least, and also think it possible by adopting wise methods to cut even larger amounts than are being taken at present and still have lumber for generations to come.

As before stated, the loss from waste in the aggregate is something enormous. It varies a great deal in different localities, being fully twenty-five per cent greater in some regions than in others, a fact that seems to have escaped the notice of many individual owners, yet a fact that it seems ought to concern them very much.

Each cutting is accompanied by great waste, not only in leaving to rot large portions of the trees actually taken, but in the destruction of young growth, and whether or not this potential loss is much greater in the frequent indiscriminate cuttings than by systematic well defined methods of operating is yet to be determined. Now certainly in localities where growth has already become the key to the situation, where the amount of young growth determines the growing power of the land, this potential loss seems to deserve careful study.

To correct these wastes, to learn what, from all points of view, is the best method of handling our forest land,we must study previous cuttings, study methods comparatively with their effects, and guide our future course thereby. In a word, we have but to use in this important matter some of the strong common sense which in other lines of business is uniformly employed.

Before we can go very far on that line, however, it seems that one definite measure must be taken. This is a change in our methods of scaling lumber. Everybody understands fully what a thousand feet of manufactured lumber means. Any school boy can easily scale a pile of manufactured lumber. But if any man,—and I mean to include our best and largest lumber dealers in the list,—can tell me what is meant by a thousand feet of logs, as the term is commonly used, I would like to hear from him. It certainly means one thing on the Androscoggin, another on the Kennebec, and another on the Penobscot.

Owing to this irregularity I venture to assert, and think I am fully warranted in the assertion, that if woods operators from certain sections of the State should contract to get lumber in certain other sections without knowing the difference in scaling, unless they were persons of large means, they would be ruined in any large operation. The same scale rule would be used in each instance, but the results would be vastly different.

Every lumber dealer should know exactly what I mean. To those who do not I will say that I very recently heard a large manufacturer state, "that he would be glad at all times to sell his manufactured lumber for a less price than he paid for the logs, on account of the overrun in scale." From my own personal experience I know that it is about as satisfactory to guess at the contents of logs as to measure them. Indeed, in many surveys of lumber the scale rule cuts very little figure. The use of it seems often to be to give a hollow appearance of painstaking and accuracy.

All this considered—the inadequacy of the rule as a measure, its liability to abuse, and the waste directly caused, the question comes home to us pointedly, why not establish a uniform and reliable method under which all parties can feel confident and safe? The adoption of such a system is strongly recommended.

One further idea suggested to us, growing out of the work already done, is the great utility of what might be called a topographical and timber survey of all the wild portion of the State. The results of it should be a full knowledge of our resources in timber. Tributary to that must be knowledge of topography and the growing power of the land. Methods must be rough and results only approximate. That, however, will not practically decrease their value.

Knowledge of this kind must be some time gained for the whole country. It can only be got by work that is local in scope and that deals strongly with details. Its value for the State of Maine cannot be too highly set. Without it no intelligent public policy toward the forests and lumber business can be established. Without it individuals cannot manage to best advantage their own possessions. At present we are in complete lack of any such information. Without appreciation of it as a public work and reasonably generous support by the people of the State of those who are ready to lead in the matter, the acquisition of it must be long postponed.

This department has done what it could with the means at hand, more, indeed, than could fairly be expected of it. We have shown what there is to gain, and have shown further how it is to be gained. Without more liberal support, however, the work must stop.

The results of our efforts are given to the State hopeful of approval as regards both matter and spirit. As the final result of our labor and consideration we commend to the people of the State the care of the forest, believing that in its preservation and intelligent handling is one help to our future prosperity.

APPENDIX.

A—Statistics Relating to the Kennebec.

APPROXIMATE SETTLED DEMAND FOR SOFT WOOD LUMBER ON THE KENNEBEC AS INDICATED BY THE CONSUMPTION OF 1895 AND MILL CAPACITY AT THE END OF THE YEAR. IN MILLION FEET B. M.

Towns.	For pulp and fiber.	For saw lumber.
At Madison	10	
At Solon	7	
At Skowhegan	2½	4
At Fairfield[*]	....	22
At Winslow	8	7½
At Augusta	3½	9
At Hallowell[†]	....	7
At Gardiner	6½	[‡]40
At Bowdoinham	....	6
At Wiscasset	....	5
At Bath	....	8½
Total	37½	109

[*] A fiber mill here making ten tons per day uses spruce saw mill waste. Two saw mills burned here in 1895.

[†] Not running in 1896.

[‡] Not so much by fifteen millions consumed in 1895.

The above figures are for mills on the main river, getting their logs from it. Their output is almost entirely for export from the State. Of the total cut, 80 to 85 per cent is spruce. All of the lumber consumed for pulp is spruce.

A little of the above demand has in recent years been satisfied from other than Kennebec sources. A little pulp wood has come in by rail from the drainage of the Penobscot and elsewhere. Some Canadian spruce has been floated down the river, from the crossing of the Canadian Pacific below Moosehead. Of the main river drive, about five millions in 1894 and nine millions in 1895 were brought from the Penobscot at Northeast Carry.

Additional spruce consumption on the drainage of the Kennebec is about as follows: At Benton is a pulp mill using poplar and spruce mainly. 2,000 to 2,500 cords of spruce are generally used, obtained from the Sebasticook river. At Reddington is a mill that has within the last few years nearly cleaned the spruce off the township tributary to it. At Lowelltown are three saw mills, shipping their product by the Canadian Pacific Railway. Several small mills shipping by rail are located on the Sandy river. All these items together, as near as I can learn, amount to nearly thirty millions.

The consumption of small mills on the Kennebec for local use has not been ascertained. The aggregate of these items would be a considerable amount, no doubt. A great percentage of it, however, would probably be other wood than spruce. Pulp wood is frequently shipped from the Sandy river to the mills on the Androscoggin.

RECORD OF SOFT WOOD LUMBER CUT AND DRIVEN ON THE KENNEBEC SINCE 1852.
From the books of the Kennebec Log Driving Company.

1853	64,086,000	1875	105,479,000
1854	68,533,000	1876	113,647,000
1855	64,131,000	1877	50,698,000
1856	38,903,000	1878	93,500,000
1857	55,498,000	1879	82,667,000
1858	22,646,000	1880	77,045,000
1859	39,332,000	1881	144,380,000
1860	44,196,000	1882	127,332,000
1861	46,134,000	1883	124,247,000
1862	41,112,000	1884	106,187,000
1863	43,331,000	1885	105,703,000
1864	40,212,000	1886	103,490,000
1865	42,864,000	1887	160,797,000
1866	47,035,000	1888	132,764,000
1867	75,636,000	1889	144,586,000
1868	52,045,000	1890	159,441,000
1869	91,436,000	1891	148,855,000
1870	80,882,000	1892	144,755,000
1871	81,702,000	1893	171,428,000
1872	119,518,000	1894	105,699,000
1873	128,695,000	1895	104,360,000
1874	97,427,000	Total	3,892,414,000

Record of Soft Wood Lumber Cut and Driven on Dead River since 1866.

From the books of the Dead River Log Driving Company.

1867	17,874,000	1882	34,110,000
1868	23,586,000	1883	39,286,000
1869	24,762,000	1884	38,495,000
1870	15,925,000	1885	32,664,000
1871	20,019,000	1886	59,954,000
1872	34,385,000	1887	64,408,000
1873	49,902,000	1888	44,311,000
1874	23,720,000	1889	48,511,000
1875	19,316,000	1890	51,216,000
1876	40,200,000	1891	47,876,000
1877	11,389,000	1892	43,489,000
1878	24,446,000	1893	54,318,000
1879	15,265,000	1894	36,206,000
1880	19,801,000	1895	30,672,000
1881	38,275,000	Total	1,004,381,000

Record of Logs Cut and Driven on Moose River since 1878.

From the books of the Moose River Log Driving Company.

1879	33,387,000	1888	36,320,000
1880	44,513,000	1889	34,404,000
1881	56,216,000	1890	31,513,000
1882	47,672,000	1891	29,351,000
1883	42,679,000	1892	36,630,000
1884	34,451,000	1893	45,295,000
1885	44,126,000	1894	32,110,000
1886	51,175,000	1895	30,643,000
1887	40,215,000	Total	670,700,000

RECORD OF LOGS SCALED ON DEAD RIVER FROM 1886 TO 1894 BY ISAAC MORSE, ESQ., OF SKOWHEGAN.

	Number of pieces.	Scale.	Number of pieces.	Scale.	Number of pieces.	Scale.	Number of pieces.	Scale.
	Spruce.		Pine.		Cedar.		Hemlock.	
1886	102,176	16,528,727	6,278	1,848,400	25,612	2,108,235	963	159,738
1888	141,147	21,325,746	11,760	3,299,520	46,300	3,880,415		
1889	79,606	10,720,482	10,504	2,319,550	34,449	2,826,860		
1890	91,258	13,010,975	5,858	1,451,595	16,748	1,315,439	1,425	168,770
1891	90,373	12,363,535	7,021	1,351,350	20,497	1,530,460	371	43,005
1892	84,018	10,994,052	2,770	628,980	26,902	2,500,115		
1893	208,064	26,712,169	6,670	1,927,807	71,781	5,078,672		
1894	115,645	16,507,910	2,837	649,470	4,171	330,655		
Total	912,287	128,163,596	53,698	13,476,672	246,460	19,570,851	2,759	371,513
Average per stick	-	140.5	-	251	-	79.5	-	135

Spruce	128,163,596	79.3%
Pine	13,476,672	8.4
Cedar	19,570,851	12.1
Hemlock	371,513	.2
Total	161,582,632	

COST OF LOGS AND FACTS ABOUT PULP AND PAPER MANUFACTURE ON THE KENNEBEC RIVER.

Facts under this head have not been systematically collected. The following derived from the statements of a representative concern will be of value for their own sake and in connection with some of the ideas advanced in this report. The date of gaining this information was December 1895.

The price of stumpage on pulp logs is $1.25 to $1.50 per thousand full scale. (Standard stumpage price for saw logs is about $2.) Cost of cutting and hauling to water $4.75 to $6. Logs cost usually from $7.50 to $8 full scale delivered at the mill.

A thousand feet of logs full scale will average about one and five-eighths cords. It will make about 3,413 pounds of ground pulp. The labor cost for manufacturing is about $3.07 per ton, including machinists, etc.

A first-class pulp mill plant making 40 to 50 tons of pulp per day might cost complete, including development of power, $200,000 to $250,000. It requires about 75 men to operate it, excluding work about booms and log piles. A plant to manufacture 40 to 50 tons of paper per day would require from $350,000 to $400,000. It would require 175 to 200 hands all the year round to run it. Such a plant means the consumption of about 7 millions of spruce per year.

B—Lumber Cut on Penobscot River, Since 1831, from the Books of the Surveyor-General. In Feet B. M.

	Pine.	Spruce.	Hemlock, etc.	Total.
1832	–	–	–	*37,556,093
1833	–	–	–	44,000,845
1834	–	–	–	30,756,558
1835	–	–	–	67,431,699
1836	–	–	–	50,841,756
1837	–	–	–	61,976,832
1838	–	–	–	74,020,409
1839	–	–	–	90,767,789
1840	–	–	–	70,717,421
1841	–	–	–	82,338,639
1842	–	–	–	112,341,566
1843	–	–	–	120,137,126
1844	–	–	–	116,788,121
1845	–	–	–	154,884,849
1846	–	–	–	140,084,864
1847	–	–	–	191,136,272
1848	–	–	–	213,051,235
1849	–	–	–	160,418,808
1850	–	–	–	203,754,201
1851	143,586,200	47,567,682	10,851,948	202,005,830
1852	124,399,736	63,859,929	11,129,757	199,389,422
1853	92,484,711	78,087,096	12,370,477	182,942,284
1854	93,446,799	53,564,196	12,580,342	159,591,337
1855	123,026,157	78,337,283	10,305,753	211,669,193
1856	102,411,667	66,526,983	11,323,580	180,262,230
1857	75,816,045	56,735,284	12,557,680	145,109,009
1858	69,453,844	62,045,696	16,166,907	147,666,447
1859	84,704,700	78,066,187	15,275,553	178,046,440
1860	98,401,676	88,285,040	14,662,811	201,349,527
1861	48,238,957	72,928,910	9,874,824	131,042,691
1862	61,725,787	90,865,804	7,471,392	160,062,983
1863	63,544,438	110,304,467	16,823,364	190,672,269
1864	54,846,506	106,774,936	12,814,830	174,436,272
1865	48,296,222	107,505,867	14,078,934	169,881,023
1866	63,575,411	154,971,243	19,000,952	237,547,606
1867	51,207,174	139,445,478	15,830,706	206,483,358
1868	50,309,399	152,931,455	77,553,912	220,794,766
1869	40,980,911	133,756,757	16,103,240	190,840,908
1870	30,030,000	149,103,192	22,881,000	202,014,192
1871	42,383,000	163,121,675	21,987,000	227,491,675
1872	46,150,000	176,933,649	23,370,000	246,453,649
1873	32,586,848	129,277,908	17,337,592	179,202,348
1874	24,178,309	135,226,015	17,382,608	176,786,932
1875	22,335,849	116,664,487	15,662,793	154,663,129
1876	19,615,572	82,087,987	13,417,632	115,121,191
1877	14,704,152	85,480,149	17,683,444	117,867,745
1878	19,479,497	81,358,056	21,302,775	122,140,328
1879	17,959,415	91,907,627	12,695,220	122,562,262
1880	17,668,651	91,573,149	14,208,737	123,450,537
1881	33,732,101	104,704,537	15,912,159	154,348,797
1882	33,408,035	122,548,230	16,154,829	172,111,094
1883	26,522,485	115,348,484	19,392,223	161,263,192
1884	24,718,767	84,425,303	16,169,276	125,313,346
1885	30,480,937	94,446,522	17,867,104	142,794,563
1886	28,603,783	100,905,443	17,055,420	146,564,646
1887	29,108,725	102,746,234	17,792,578	149,647,537
1888	30,942,687	114,348,153	19,473,695	164,764,535
1889	27,885,394	121,659,086	20,665,903	170,210,383
1890	28,255,236	129,541,485	21,310,006	179,106,727
1891	23,114,771	118,205,741	23,664,844	164,985,356
1892	26,896,302	105,044,377	28,453,079	160,393,758
1893	22,425,974	81,400,612	25,447,931	129,274,517
1894	25,369,893	116,969,664	18,934,467	161,274,024
1895	27,189,050	91,488,448	25,513,996	144,191,494
Total since 1850	2,196,201,773	4,649,076,506	758,513,273	7,603,791,552
1832-1850 (mostly pine)				2,023,105,083
Total cut since 1831				9,626,896,635

*The totals to 1851 are mostly pine. No record previous to 1851.

C—Method of Computing Growth, and Yield of Second Growth in Spruce and Pine.

Each of the two previous Maine forestry reports contained a description of the method of tree measurement adopted by the United States Forestry Division for the use of its field agents. Few, perhaps, will take interest in this matter on its own account, but work of this nature is so fundamental to the results of this report that it must be once more explained.

The schedule of field measurements annexed careful attention will, I think, make perfectly plain. The figures refer to a spruce tree that grew up on a very old burn on township I, R. XIV, just east of Moosehead Lake. In getting these data an ax, a foot rule, a four-foot stick and caliper measure are the tools used. The tree desired is looked over standing, note being taken of its thrift and relation to other trees. Then it is felled and measurements taken of main features,—breast diameter, height, and relative length of trunk and crown. The diameter of the tree at every four feet is also measured, which gives its shape and volume. The tree next, if it is at the observer's disposal, is cut into desired lengths for the detail count and measurement of its yearly rings. This gives, as will be seen, a clew to the history of its development and growth.

In order to understand these detail measures it is necessary to hold in mind one principle. The yearly wood growth of a tree is deposited immediately under the bark. A thin layer is thus formed each year over the old wood and reaching out beyond it at the top of the tree. Now supposing that the deposit of rings is entirely regular—that one ring and only one ring is grown each year—which is for practical purposes the case,—it is seen that the number of rings at the stump of a tree gives its age, while the rings at any section above tells how many years were taken to grow the height that is above the point selected. Subtraction of one from the other therefore tells how many years the tree took in growing from the height of the stump to the height of the section.

POSITION: CROWN PARTLY FREE; SURROUNDING SPECIES: SPRUCE, PINE, BIRCH AND POPLAR.

Diameter breast high.	Length of timber.		Diameter below crown.	Length of crown.		Length of leader for last 5 years.	STUMP.			
							Height.	Diameter at top.	Age.	No. of rings on stump.
in.	ft.	in.	in.	ft.	in.	in.	in.	in.	yrs.	
9.5	32	–	7	33	–	32	20	10.5	10	98

DETAIL OF SECTIONS.

Number.	Height from ground.		Diameter.	No. rings.	Diameter in inches from bark through ring.							Thickness of bark at top.
	ft.	in.	in.		10	20	30	40	50	60	70	in.
1	16	–	7.8	77	.2	.4	.6	1.	1.5	2.3	3.3	.4
2	26	6	6.8	66	.2	.5	.75	1.1	1.7	2.7	–	.3
3	37	3	5.7	53	.35	.7	1.1	1.7	2.6	–	–	.3
4	47	9	4.2	38	.35	.8	1.5	–	–	–	–	.25
5	58	6	–	16								

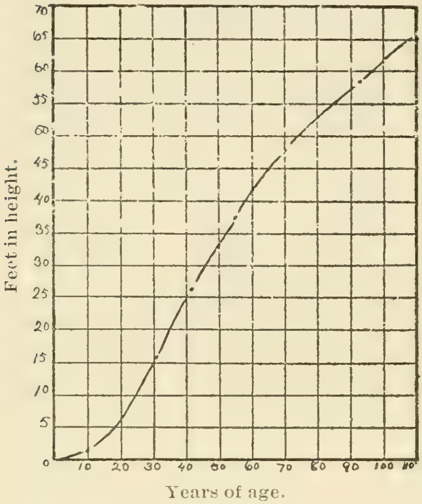
Diameter at	4 feet,	9.5 inches.
"	8 "	9.3 "
"	12 "	8.9 "
"	16 "	8.6 "
"	20 "	8.4 "
"	24 "	8. "
"	28 "	7.6 "
"	32 "	7. "
"	36 "	6.5 "
"	40 "	5.8 "
"	44 "	5.4 "
"	48 "	4.5 "
"	52 "	3.5 "
"	56 "	
"	60 "	
"	64 "	

AGE OF TREE, 108 YEARS; TOTAL HEIGHT, 65 FEET.

Age of tree.	Height from the ground.	
Years.	Ft.	In.
10	1	8
31	16	–
42	26	6
55	37	3
70	47	9
92	58	6
108	65	–

To illustrate—this tree was cut leaving a stump 20 inches high. In the stump were 98 rings. 14 feet and 4 inches higher, or 16 feet from the ground, the tree was cut off and 77 rings counted. We know, therefore, that the tree in growing from 20 inches high to 16 feet occupied 21 years. The next 10 1-2 feet in a similar way are found to have been grown in 11 years. Adding to the 98, 10 years for the age of the stump, the tree when cut is ascertained to be 108 years old. It is now 65 feet high. All these facts relating to height growth are gathered into the accompanying table.

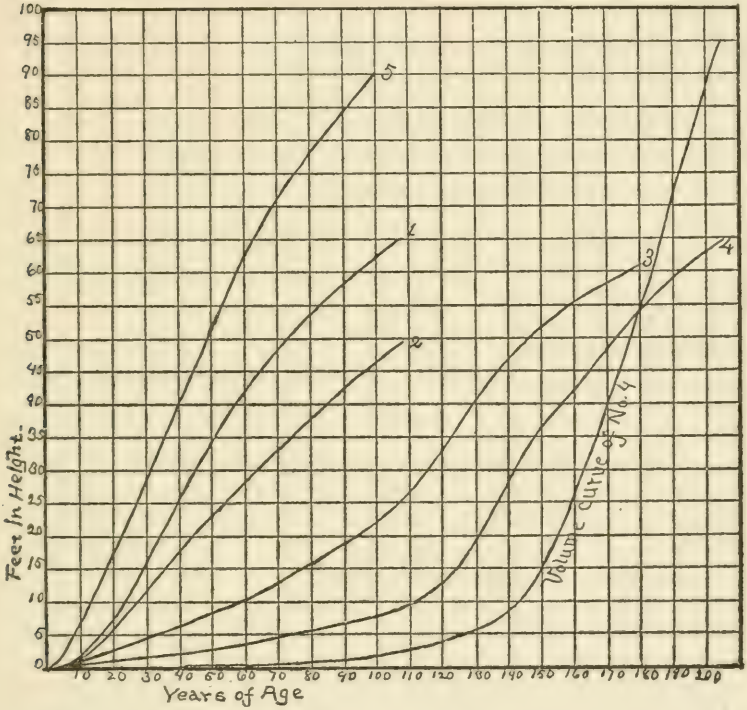
Height curve of a spruce grown on open land.



There is a graphical way of placing these facts before the eye, one that is especially useful when comparison is necessary. Let us, for instance, take a sheet of paper that has been ruled off into squares. Our zero point is at the lower left hand corner. Along the horizontal line running from that we will place at regular intervals the numbers 10, 20, 30, 40, etc., representing years of the tree's life. Height on the other hand will be spaced off on the vertical line, each space representing a height of 5 feet. Now from the table just given the tree at 31 years of age is found to have attained a height of 16 feet; so just to the right of the vertical line up from 30 and just above the horizontal line across the page from 15 we will put a dot. Again at 42 years of age the tree was 26 1-2 feet high. Another dot, therefore, is put in where lines up from 42 and across from 26 1-2 intersect. So with each point given in the table, including the stump and the present height and age. The points then may for clearness' sake be connected by a curve, the rise in which shows at a glance the height growth of the tree. The slow growth of the young seedling is indicated by the slow rise of the first end of the curve. Along at 10 to 15 feet the height growth reaches its maximum rapidity. It does not begin to slack much till it has reached 40 to 50 feet.

The value of this method of representation will be best brought out by comparison. The tree so far dealt with grew up on a piece of ground that was burnt something over 100 years ago. It has had therefore throughout its life the benefit of unobstructed sunlight. It grew moreover out of a liberal soil, favorable conditions in general being indicated by the large and thriving pines which stood in its immediate neighborhood. Now a short distance away, on the same area of second growth, was flat and very rocky ground, with hardly any soil except the mold formed from the decaying sticks and leaves. This had seeded to the same kinds of trees as the other ground, but the trees though close together were much smaller and far less thrifty. The pines had been specially affected. They were small and spindling, and plainly never would reach the size of practicable lumber.

Now note the effect of the poor soil conditions on the height growth of the spruce. A tree cut here measuring 7 1-4 inches in diameter and 49 feet high bears about the same relation to its neighbors as did the other tree to those in its immediate vicinity. It is found to be of the same age as well. Now note in the figure next given how plainly the difference in thrift is shown. Curve 1 is the same one that was given before. 2 is the height curve of the tree on poorer soil. The shrinkage is striking in amount, and persists through the life of the tree. The effect of soil conditions on the height growth of the tree is thus illustrated and proved. Diagrams like this might be used as a measure of such effects.



Height curves, showing comparative growth of spruce and pine and of spruce under different conditions.

1. Curve of spruce on good soil—land cleared by fire.
2. Curve of spruce on very poor soil—land cleared by fire.

3 and 4. Curve of spruces grown up in mixed land under shade.

5. Pine on same site as No. 1.

These trees, it was stated, grew up on cleared land where they had the advantage of unobstructed sunlight throughout life. They might be called normal trees, showing for the climate and site what the species will do. But a small proportion, however, of the trees that make up our spruce lumber have grown up in any such way. Most have grown up under a shade, often a dense and overpowering one, and the effect of this limitation, no less plainly than of the other, is shown by the height curves.

No. 3 for instance is the curve of a tree 13 inches in diameter that stood in hard wood land on the town of Brassua on Moose River. At 108 years of age it was only 25 feet high. Clearly it had up to that time been densely shaded. Some time not long after that, however, the growth must have opened up around it, for the line at that point begins to rise fast. Probably surrounding trees rotted or blew down. The tree at any rate by some means got access to light and air, and it quickly proved proved itself able to use them to good advantage. So with the next one, No. 4, from 5 R. 3 on the Magalloway River. This tree in early life was long and hard suppressed. At 125 years of age it was only 15 feet high and contained probably not more than 1 cubic foot of wood, yet even by that treatment the vitality was not crushed out of it. Getting finally free from suppression, it at once began a height growth equal to that of young trees of the same size that had always been open. In the last 80 years 50 feet has been added to its height, while vigorous growth is still maintained. In such ways does a curve of this kind give us at a glance a fair idea of the history of a tree. As to maximum height, it is plain that the trees whose height growth is here plotted have not yet reached it. Perhaps it would have been gained at 80 feet, when the curve would become nearly horizontal.

A comparison of different species in the same manner would be well worth while. Curve No. 5, for white pine, may be compared with No. 1, for spruce in the same conditions. No pines were cut at this point, but numerous trees had reached the height here represented, and the course of the curve I am able to put in from figures gathered elsewhere. Good pines on this soil reached in 100 years a breast diameter of twelve to 18 inches and a height of 90 feet. Spruce in the same conditions gained a size of 8-12 inches and height of 60 feet. Both were grown in strong competition with neighbors. Open grown trees of whatever species are, of course, quite a different matter.

The further question arises—how much supression will pine stand and still survive it? Everyone who is familiar with our northern woods knows that it will not stand any such treatment as spruce. It can, in fact as near as I have been able to learn be kept down to about half its normal height development, crowded down say to a height of 40 or 50 feet at 100 years, without being killed by the process. That height growth would be represented by a curve about like No. 2 in the figure.

What for practical purposes we most want to know about trees is the amount of wood they contain and the history of its deposition. Turning back to our tree schedule it is plain that on the former point the caliper measurements give us full information. These were taken 4 feet apart along the tree up to the point where it was 3 1-2 inches in diameter. To get the volume of the tree, cylinders of the right size and number and each 4 feet long must be added together and a fair allowance made for stump and top. For this work a table of contents of cylinders is very handy. This not being commonly found in books, an extract from it sufficient for figuring on our common Maine trees is given for the convenience of any who may wish to use it.

CONTENTS OF CYLINDERS FOUR FEET LONG WITH ANY GIVEN DIAMETER.

Diameter, inches.	Volume, cubic feet.	Diameter, inches.	Volume, cubic feet.
2	.09	16.5	5.94
2.5	.14	17	6.31
3	.20	17.5	6.68
3.5	.27	18	7.05
4	.35	18.5	7.47
4.5	.44	19	7.88
5	.55	19.5	8.30
5.5	.66	20	8.73
6	.79	20.5	9.17
6.5	.92	21	9.62
7	1.07	21.5	10.08
7.5	1.23	22	10.56
8	1.40	22.5	11.04
8.5	1.58	23	11.54
9	1.77	23.5	12.05
9.5	1.97	24	12.57
10	2.18	24.5	13.10
10.5	2.41	25	13.64
11	2.64	25.5	14.19
11.5	2.89	26	14.75
12	3.14	26.5	15.32
12.5	3.41	27	15.90
13	3.69	27.5	16.50
13.5	3.98	28	17.10
14	4.28	28.5	17.72
14.5	4.59	29	18.35
15	4.91	29.5	18.99
15.5	5.24	30	19.63
16	5.59		

In this connection it will be well to explain a mode of reckoning which, itself a result of long study by the most accurate methods, gives us a short cut to approximate results. This is the use of the so-called form number or factor of shape. This is based on the tree's height and breast diameter. Breast diameter, or the diameter at about four-and-one-half feet from the ground, is the standard of diameter measure used by the Germans; it has also been adopted by the United States Division of Forestry, and it will be well if all who study trees in this way will adopt the same practice. Diameter four and one-half feet from the ground is easier to take than a stump diameter, and it is also much more reliable and satisfactory.

On the height and breast diameter of a tree then is based its factor of shape. Let us suppose a cylinder equal in height to the tree and having a base equal in diameter to the diameter of the tree breast high. Then the factor of shape is the percentage of this cylinder which the actual contents of the tree constitutes. Thus the total contents of the tree recently scheduled was 17 cubic feet. Its diameter breast high was 9 1-2 inches and its total height 65 feet. A cylinder of those dimensions contains 32 cubic feet. Now as 17 is 53 per cent. of 32, the factor of shape of this tree is .53.

Much might be said on this topic if it were desirable. When based on many measurements, limited as to size, species and conditions, this method of reckoning is for general averages a very handy and satisfactory one. Further than to explain it I wish to speak of it in only one connection. The factor of shape for small spruce trees in our woods, those say up to 12 or 14 inches diameter, and for the young pines also on our second growth lands is near enough for practical purposes .5. That is, if you know the height of a tree and its diameter 4 1-2 feet from the ground, the volume of the tree will be half the contents of a cylinder of the same dimensions.

Tree volumes for scientific purposes are usually reckoned bark on, but the tree schedules provide data for determining the net wood volume. Here again a rough and ready figure for our spruce and pine of ordinary sizes is 1-6 or 16 2-3 per cent. That is, to get the net wood volume of a tree from the volume derived from measures taken outside the bark 1-6 must be deducted.

One section of the tree schedule has not yet been referred to. That is the detail of sections. The tree under discussion was cut off at 5 points between 10 and 11 feet apart, one kerf of each cut being squared. The diameter of this was measured inside the bark, a pencil line drawn from the heart to the bark at some point where it equalled the average radius of the section, and then the rings of yearly growth were counted, beginning with the bark and marking every tenth one. Finally the breadth of these groups of rings is measured, or what amounts to the same thing, the distance of each mark made from the bark end of the line.

Thus turn to section 1 in the schedule. It was put in at 16 feet from the ground, and the diameter of the wood at that height was found to be 7.8 inches. An average radius then is 3.9 inches and this was drawn on the kerf in pencil. Count of the yearly rings along this line shows there are 77 of them. The outer 10 rings are together only .2 inches thick, the next 10 rings are of the same thickness, and so with the third group. Inside that, the rings are thicker. Similarly with the second and higher sections. Those who are willing to give the matter a little close attention will find themselves amply repaid for carefully comparing these measurements. This tree I may say seems to be for its conditions a very typical and regular one.

Now since we know from the caliper measures and the measured thickness of bark what the true wood volume of the tree is, since, as just noted, we know also how thick a layer at different heights in the tree the wood grown in the last 10 years amounts to, we have, it will be seen, the means of calculating how much wood has grown in the last 10 years, or, what amounts to the same thing, how big the tree was 10 years ago. The process of calculation I need not explain. A man who knows enough mathematics to figure out the problem if told how will be able to plan his own solution. I will refer, however, to pages 85-92 of the last Maine report and the diagrams there given as perhaps throwing light on the whole subject.

And if 10 years back, then 20, 30 and 40. The diameter of the tree at any age at different heights, and consequently data for determining its volume, are all contained in these measurements. The more sections there are, the more accurate will the results be.

Let me now give a little table showing as the result of calculation the history of this tree's growth. All volumes include bark. Under 50 years of age it must be said we have not sufficient data for calculating the volume of the tree. This part of the table was put in largely by guess.

Here again, to show the gain in volume, the graphic method may with advantage be brought in. We will bring forward here the curve for height growth which was first plotted, and draw on the same piece of cross section paper the curve for volume, cubic feet of contents being indicated on the right hand vertical line. In comparison with height growth the early growth in volume is seen to be extremely slow. At fifty years of age, this tree is growing about as much wood as it does any time later. No appreciable shrink in its volume growth, however, is indicated, as was the case in regard to height.

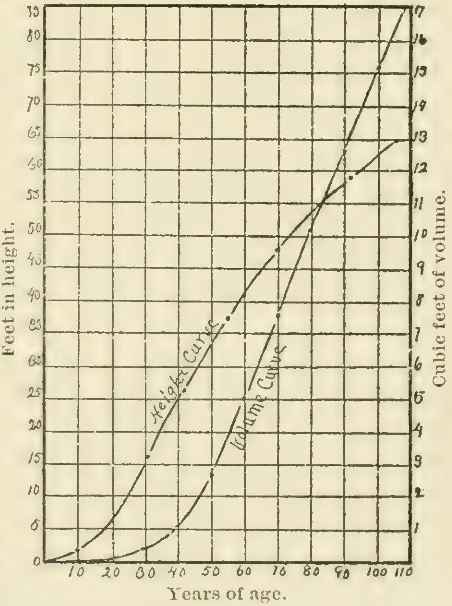
HISTORY OF A TREE'S GROWTH.

Age.	Height, feet.	Volume cu. ft.
10	$1\frac{2}{3}$	.001
20	6	.03
30	15	.4
40	25	1.1
50	33	2.7
60	41	5.0
70	48	7.5
80	53	10.2
90	58	12.7
100	62	15.1
108	65	17.0

The tree, in fact, might go on to 200 or 300 years of age with an equal or greater volume increase. This would be gained mostly through growth in diameter. Comparitively little gain in height would be made during the time.

This tree, it will be remembered, grew up on cleared land, in fairly dense growth, among competitors of equal strength. Its history in respect to volume, as well as height, might be considered normal for the species. A spruce starting in shade grows wood for many years at an extremely slow rate. Becoming free at length, a tree in natural woods very often is never afterwards crowded, so its volume growth not only accelerates, but it keeps on accelerating. That is, it grows more wood when it was 15 or 16 inches in diameter than it did when it was 12 or 13. Its curve in consequence, keeps on mounting at a faster and faster rate. These points will be seen on looking at the second set of curves that were given. For tree No. 4, both height and volume curves were drawn.

Growth in height and volume.



A book of 1000 pages could be filled with facts of this description. The present purpose is only to exemplify them and show how they might be handled. There is, however, another set of relations which I wish to develop from the original figures.

Let us bring forward the figures showing the volume of our sample tree at different ages from ten years by decades up to 100. Then subtracting volumes from one another in turn and dividing by 10 gives the average yearly growth for the period. A look at these figures shows that they increase very rapidly at first, at 60 to 70 years reach in this tree .25 of a cubic foot and remain there practically stationary up to 100. This last relation can hardly be called fortunate. Our sample tree would have better represented the vigorous trees of the stand if its growth in these later decades had kept on steadily but slowly increasing.

Age.	Volume, cu. ft.	Yearly growth during last decade, cu. ft.	% of yearly growth to volume.
10	.001	.0001	
20	.03	.0029	
30	.4	.037	
40	1.1	.07	
50	2.7	.16	6.0
60	5.0	.23	4.6
70	7.5	.25	3.3
80	10.2	.27	2.6
90	12.7	.25	2.0
100	15.1	.24	1.6

Let us now look at the figures from the point of view of percentage. At 50 years the sapling contains 2.7 cubic feet. The average yearly growth for the last decade was .16 cubic feet, 6 per cent. of the stated volume. At 60 years .23 of a cubic foot is 4.6 per cent. of 5 cubic feet, the volume of the tree at the time. So on down the list a shrinking rate is seen. At 100 the yearly growth is .24 cubic foot, almost exactly the same as at 60 years, but the ratio this bears to the volume of the tree at the time is only 1.6 per cent. The course of these percentages in this simple and typical instance is well worth careful consideration. The same thing has been often referred to in the body of this report, for it is a very practical and oft-recurring matter. What is true of one tree is true of thousands. A piece of timberland may be growing a big percentage on the small growth that stands on it, and yet be producing but a small amount of wood; while on the other hand land stocked with trees of good size, though it may be gaining but a small interest on the value of the timber, may be growing in fact a very large amount. This is a fact very important for managers of timberland to understand.

There are a dozen directions in which the current of what has so far been said could be turned. Perhaps it will be best to take the tree which has so far been used as an illustration of method, assemble the facts determined in regard to it, as well as for two or three of its immediate neighbors, and proceed with their aid to the solution of a larger problem —the history of the growth of wood upon the ground on which these trees stood.

The first thing to do is to ascertain what is now standing on the land. This piece of ground was visited by the writer in August, 1895, it being the same piece of second growth that was referred to on page 67 of this report. In a region of dominant spruce, where the ground was well and evenly covered, a fair sample quarter acre was run out, which was found to be covered with trees as follows:

QUARTER ACRE ON TOWNSHIP I, R. XIV, PISCATAQUIS COUNTY.

Land burnt over about 108 years ago. Ground uneven, without strong slope. Soil stony, sandy loam covered with mold.

Diameter of trees.	Spruce.		Diameter of trees.	Other Species.						
	Number.	Volume cubic feet.		Pine.	Fir.	Poplar.	White Birch.	Beech.	Maple.	Volume cubic feet.
14	1	36	24	1	–	–	–	–	–	150
12–14	* 4	107	16–18	3	–	–	–	–	–	220
10–12	* 9	172	14–16	1	–	3	1	–	–	250
8–10	23	345	12–14	4	–	3	–	–	–	210
6–8	18	145	10–12	2	–	1	1	–	–	80
3–6	18	55	8–10	4	–	–	3	–	–	85
			6–8	–	–	–	3	1	–	25
	73	870	3–6	–	–	–	2	–	–	5
			Under 3	–	–	–	–	–	3	25
				15	†	7	10	1	3	1,050

* Including one white spruce in each class.

† Multitude, up to three inches diameter.

Average height of dominant spruce about 60 feet. Tallest pine 100 feet. Usual pines, birches and poplars from 60 to 90.

Some dead spruce, poplar and birch standing.

PER ACRE—Spruce, 292 trees, 3,480 volume cubic feet; pine, 60 trees, 2,550 volume cubic feet; all species except fir, 436 trees, 7,680 volume cubic feet.

In examining the stand of this quarter acre it is note-worthy that the pine, poplar and birch together contain more wood than the spruce. These species, in fact, form an imperfect overgrowth, higher than the spruce, to which the slower-growing spruce might be looked on as an undergrowth. The spruce, however, is what we are concerned with. There is more of it than of any other species, not so very much less probably than if there had been no other species on the ground. Let us bring the spruce forward again, condensing the table somewhat for reasons that will soon be seen. We will also note for each group of trees into which the whole number is divided, the average volume per tree.

This division on the basis of size has a correspondence in the surroundings and condition of the trees. The largest trees are those with largest crowns and most room, advantages which were very likely gained in the first place by an early start. Medium sized trees generally resemble one another in having a compressed or somewhat thin crown. The smallest trees have small and thin crowns and in height are often greatly overborne. Size then goes along with present condition and with past history.

Diameter of trees.	Number.	Volume, cubic feet.	Average volume.
10 and over.	12	275	23
8–10..........	23	345	15.2
6–8...........	18	145	8
3–6...........	18	55	3
	71	820	

The 71 trees on the area have been divided into 4 classes according to size. The average volume of trees of the first class is 23 cubic feet, of the second 15.2, of the third 8, of the fourth 3. Now if out of the grove as it stands, we should choose trees of just these volumes, trees too that fairly represent their classes in regard to height, condition and crown development, if we should cut these 4 sample or model trees down, measure them in the way recently illustrated, and from these schedules by computation get at their history, these 4 trees it will be seen, if good judgment and good luck both accompanied the selection, might stand for their respective groups. This again is a method of figuring used by the Germans in reckoning with their forests, but over and above any question of authority it is a method both convenient and satisfactory, one approved in other words by common sense.

In order to fill the requirements exactly, 4 model trees are called for, representative of their classes in respect to height and crown development, and of size and volume as follows:

1 tree over 10 inches in diameter, with volume of 23 cubic feet.
1 " 8–10 " " " " 15.2 "
1 " 6– 8 " " " " 8 "
1 " 3– 6 " " " " 3 "

In filling this bill I had cut in the woods and subjected to detail measurement.

1 tree 11 inches in diameter, with a volume of 23 cubic feet.
1 " 9.5 " " " " 17 "
1 " 7.2 " " " " 8 "

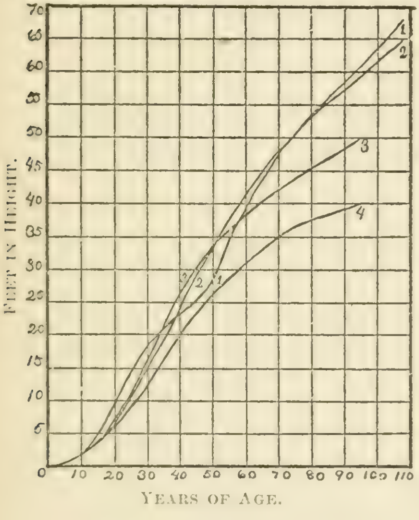
Two of these fit the requirements perfectly. The third can be made to do so by the use of a converting factor. None of the small, suppressed trees were cut, so the data for that class we shall have to put in by guess.

Now from what has gone before it will be seen at once what facts are wanted in the history of these trees, and it will be quite as evident how they are obtained. It is necessary only to state the principal dimensions of the three trees, and to show their development in height and volume. The two largest trees appear to be of the same age—108 years. This we will assume as the age of the grove as well. The size of the trees measured is given at 10-year periods, at the end of each decade from the 5th to the 10th. Back of 50 years some of the facts desired cannot, from data in hand, be accurately obtained. A suppositious 5 inch tree, representative of the smallest class into which the stand was divided, we will at the same time put in by guess.

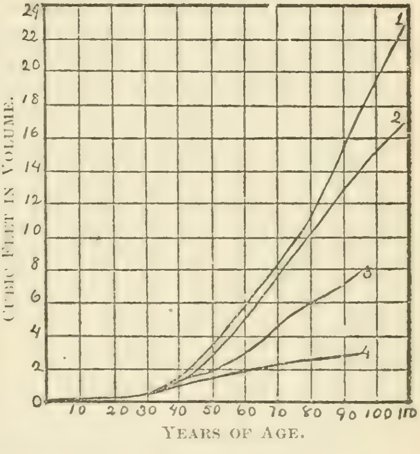
Number of tree.	Age.	Breast diameter. in.	Height. ft.	% of height in crown.	Volume. cu.ft.	Rate of present growth. %	At 50 yrs. Height.	At 50 yrs. Volume.	At 60 yrs. Height.	At 60 yrs. Volume.	At 70 yrs. Height.	At 70 yrs. Volume.	At 80 yrs. Height.	At 80 yrs. Volume.	At 90 yrs. Height.	At 90 yrs. Volume.	At 100 yrs.* Height.	At 100 yrs.* Volume.
1	108	11	68	50	23	2.4	28	3.4	39	6.	47	8.2	53	11	58	15.3	64	19.1
2	108	9.5	65	51	17	1.6	33	2.7	41	5.	48	7.5	53	10.2	57	12.7	62	15.7
3	95	7.2	50	48	8	2.8	23	1	32	1.7	37	2.5	41	4.1	44	5.7	47	6.7
4	95	5	40	35	3	–	18	.7	24	1.4	30	1.8	34	2.2	37	2.4	39	2.6

* At 50, 60, etc., years from start of grove, 108 years ago, not from start of each tree.

Height growth of different trees in an even-aged stand, grown up on open land after fire.



Volume growth of same trees.



With these facts in hand, facts which are put before the eye again in the shape of height and volume curves drawn on the same scale as before, it is only necessary, in order to get the stand on the area at any given time, to multiply through the contents of each of the model trees at that time by the number of trees which in the present stand it was made to represent. Thus at 60 years of age the larger trees in the stand are seen to have been about 40 feet high. From data not here given they are found to have been about 7 inches in diameter as well. Number 1 at that time contained 6 cubic feet, and to get the stand of the quarter acre it is to be multiplied by 12, the number of trees in the present stand of which it is the representative. Numbers 3 and 4 have similarly to be multiplied by 18 each, while number 2, representing 23 trees in the original stand has to be multiplied only by 20.7. This tree, it will be remembered, was a fraction too big to represent its class exactly, and the relation may be supposed to steadily hold. The stand of the quarter acre at 60 years of age then adds up as shown—232 cubic feet.

Model tree.		Number trees in class.	Volume cubic feet.
Number.	Volume.		
1	6	12	72
2	5	20.7	104
3	1.7	18	31
4	1.4	18	25
Total volume....			232

So much for the method, which is better than this illustration of it might lead one to expect. Tree number 3 was not a good sample of its class. Early figures based on it are, there is little doubt, too low, and the quarter acre at 60 years consequently is not given a big enough stand. One thing, moreover, is omitted that would be necessary to make the thing exact and perfect. That is the trees that in course of time and under the power of competition have died. There is enough of that in such a case to make a large difference in the yield of the land. The German in his carefully tended forests uses this material. In our own woods it falls down and rots. In order to ascertain the correct full stock of our spruce for given land at any age, a matter indeed which has for us at the present time only a theoretical interest, the history of a grove would have to be watched for a long period, or different groves found for comparison, in the same conditions but of different age. Some time not far distant perhaps our timber trees will come to be studied in this way. If so, what has been written here may prepare the way for comprehension of the results.

In digging out and piling up these complicated relations the plain and practical bearings of the facts presented must not be covered up out of sight. Here is a well soiled piece of ground, burnt over something like 108 years ago, on which there came up a thick stand of spruce associated with quicker growing birch and pine. At the end of the time stated the larger spruce are 10 to 13 inches in diameter and 60 to 70 feet high. An acre stocked like our sample would yield about 30 cords of spruce pulp wood counting in considerable of the knotty tops. Without the birch and pine the spruce alone would have yielded 45 cords, let us say. This is for thickly stocked land. Scattering trees, while at the same age they are of much larger size, while at a much lower age they come to merchantable dimensions, produce neither clear lumber, nor a large yield of wood per acre on the land.

Now while this yield after 108 years of an average of 45 cubic feet, or about two-fifths of a cord of pulp wood, per acre and year is a very respectable one, while it is several times as much as the figures for growth of spruce which in the body of this report have been attached to most areas of cut-over old growth land (a fact which shows by the way that stripping off spruce land would be no calamity if it only reseeded to spruce and the succeeding growth should be protected to maturity)—yet compare the yield of this area of spruce with that of a piece of ground of the same size in pine. The figures here given were gathered at Saco in a pine grove which was apparently 50 to 55 years old, standing on sandy land. The spruce figures are brought forward and placed alongside for comparison. They have, however, been raised 50 per cent all through in order to allow for the influence of the birch and pine which stood over the spruce on this sample area.

Comparative Yield of Spruce and Pine Grown up Thickly on Open Land.

Diameter.	Spruce at 108 Years.		Pine at 54 Years.	
	Number of trees.	Volume—cu. ft.	Number of trees.	Volume—cu. ft.
10 inches and over	18	412	21	380
8-10 inches	34	517	25	300
6-8 inches	27	218	35	250
3-6 inches	27	82	40	100
Total	106	1,229	121	1,030

Now, on page 185 of this report it was said if our spruce ever gave out and we wanted to grow timber to supply our pulp mills, that if the pulp mill men would content themselves with pine lumber we could cover a large section of the State over with thick pine groves producing great amounts and values. These figures will help justify a part of that statement. They will show at any rate why it is to pine and not to spruce that we should probably look in any such emergency. Such comparative figures of course would not hold in all conditions true. So far as I can judge, however, these figures are somewhere near representative of their respective species.

D—Growth on Spruce in Cut-Over Lands in Per Cent and Amount.

On pages 26 to 28 of this report Pressler's tables for determining the percentage of growth of trees were explained, and illustration given of their use. Later, on pages 56 and 123, were given some of the general results arrived at by this means. It remains now to record the results in full and to state or restate the most important inferences derived therefrom.

The observations made were all on spruce trees, on those of small and medium size. When notes of this kind were taken note was also made of the soil, nature of growth, etc., and the tree observations have been divided in accordance therewith. Thus the figures obtained on the Kennebec were divided into 3 groups, for spruce in hard wood or mixed land, and in thrifty and unthrifty black growth respectively.

The following table embraces the results obtained for spruce in hard wood land, land, that is, in which hard woods form half or more than half the stand. The trees have been grouped according to diameters—that is observations on all trees of the same diameter breast high were averaged together to obtain the figures here given. The recorded or actual computed results are arranged in the first five columns. By plotting the values there given for volume and per cent. and drawing a smooth curve following their course, irregularities have been taken out and the true relation made clearer. These corrected values are in the last four columns.

SPRUCE ON WELL SOILED AND WELL DRAINED LAND. SOIL COVER LEAVES. HARD WOOD HALF OR MORE THAN HALF THE GROWTH.

COMPUTED RESULTS.					SAME EVENED BY DRAWING CURVES FOR VOLUME AND PER CENT.			
		GROWTH LAST TEN YEARS.				GROWTH LAST TEN YEARS.		
Diameter—inches.	Estimated volume—cubic feet.	In diameter—inches.	In per cent at compound interest.	Number trees involved.	Volume—cubic feet.	In diameter—inches.	In per cent at compound interest.	Yearly growth—cubic feet.
7	4.6	.7	2.7	5	4.5	–	–	–
8	7.6	1.26	4.3	8	7.5	1.2	4.2	.315
9	10.9	1 26	3.9	14	10.5	1.35	4.1	.43
10	12.7	1.52	4.1	19	14	1.4	3.9	.55
11	18.3	1.5	3.7	26	18	1.42	3.55	.64
12	21.8	1.4	3.1	22	22	1.42	3.2	.70
13	26.4	1.3	2.6	14	26.5	1.35	2.8	.74
14	31	1.2	2.5	13	31	1.31	2.5	.78

121 trees observed in all, one-third of which stood on Dennis, Somerset county; the remainder on various Kennebec townships between Hobbstown and Roach River. Average height above sea about 1,200 feet.

There are certain relations running through these figures that are of the greatest practical importance. First let us examine the figures for the amount of yearly growth. According to the table a tree 8 inches in diameter produces yearly about .3 of a cubic foot. At 9 inches it grows half as much more, at 11 inches twice as much, and beyond that point the increase though at a smaller rate steadily goes on. The cause of this is easy to understand. It is twofold. In the first place the larger a tree the larger as a rule is its crown—the greater, that is, the area of its leaf surface and its consequent power to grow wood. The other reason is in the tree's surroundings. A small tree as a rule is more shaded than a tall one. Only when a tree reaches a considerable size does it in ordinary circumstances have room and light for vigorous growth.

Now the practical point in this, if the tree is cut while it is still small, all the period of its rapid volume growth is lost. That is to cut off its life just as it is beginning to produce something.

Now how long can a tree be profitably left to grow? How long does this increase in its yearly production continue? The same column of figures answers this question. For fine points it could hardly be trusted, but in regard to the general tendency there can be no mistake. There is no slack in the rise of the growing power of the tree as far as it has been observed. A tree 14 inches in diameter grows on the average more wood per year than one 13 or 12. The longer it stands, up at least to this point, the greater the production of the tree and the land.

Entirely different is the course of the percentages. These are, to be exact, the rate of growth of the tree at compound interest during the last 10 years. These, it will be seen, have been steadily shrinking. As growth adds to the volume of the tree, the addition of each year though greater in actual volume bears a less ratio to the volume of the tree at the time. Thus while at 8 inches in diameter a tree may grow .315 cubic foot which is 4.2 per cent of its volume at the time, at 14 inches in diameter a yearly growth of 78 cubic foot is only 2.5 per cent of the volume at that time. Consideration of the actual amount of growth will in most cases incline one toward conservatism in the handling of timberland more than that of percents.

SPRUCE ON SPRUCE LAND OF FIRST QUALITY. LAND UNEVEN AND WELL DRAINED. SOIL GENERALLY SMALL IN QUANTITY, COVERED WITH MOSS.

COMPUTED RESULTS.					SAME EVENED BY DRAWING CURVES FOR VOLUME AND PER CENT.			
		GROWTH LAST TEN YEARS.				GROWTH LAST TEN YEARS.		
Diameter—inches.	Estimated volume—cubic feet.	In diameter—inches.	In per cent at compound interest	Number trees involved.	Volume—cubic feet.	In diameter—inches.	In per cent at compound interest.	Yearly growth—cubic feet.
7	5.9	1.13	4.5	7	6	1.1	4.3	.26
8	7.6	1.14	3.9	31	8	1.15	4.1	.33
9	10.3	1.22	3.7	46	10.5	1.2	3.7	.39
10	14.2	1.10	3	60	14	1.23	3.25	.45
11	17.7	1.3	3.1	61	17.5	1.23	2.9	.51
12	21.6	1.2	2.6	56	21.5	1.23	2.6	.56
13	25.8	1.26	2.6	46	26	1.22	2.4	.62
14	31	1.17	2.2	33	31	1.2	2.2	.68

Three hundred and forty trees observed in all, mostly from Dennis, Brassua, I, R. XIV, and A and I, R. XII on Roach River. Mostly underlaid by slates. Average height above sea about 1,200 feet.

Spruce on Slow-Growing Spruce Land. Land Flat and Poorly Drained, Rocky, with very Little Mineral Soil. Deeply Mossed.

Computed Results.					Same Evened by Drawing Curves for Volume and Per Cent.			
		Growth Last Ten Years.				Growth Last Ten Years.		
Diameter—inches.	Estimated volume—cubic feet.	In diameter—inches.	In per cent at compound interest.	Number trees involved.	Volume—cubic feet.	In diameter—inches.	In per cent at compound interest.	Yearly growth—cubic feet.
7	5	1	4	2	5	-	-	-
8	7.4	.95	3.3	15	7.5	.95	3.25	.24
9	10.2	.9	2.6	13	10.5	.97	2.9	.30
10	12.4	.97	2.6	14	13.5	.96	2.55	.34
11	16.5	.8	1.9	11	16.5	.93	2.2	.36
12	19.6	.97	2.1	11	19.5	.88	1.9	.37
13	23	.9	1.8	9	23	.82	1.65	.38
14	28.6	.65	1.2	8	27	.75	1.4	.38

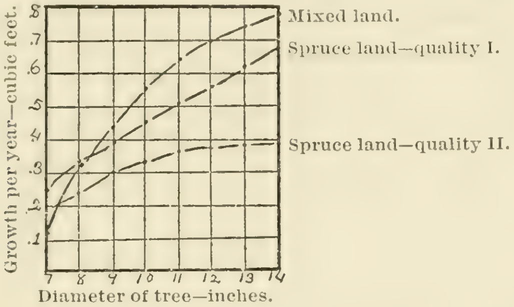
Eighty-three trees observed in all, on Hobbstown, No. IV, R. VII and No. I, R. XIV. Average height above sea about 1,400 feet.

Examine now the companion tables, for spruce land of best and of poorer quality, The better spruce land is seen to grow at a rate nearly equal to the spruce of the better soiled hard wood land—nearly but not quite. The amounts of yearly growth follow the same law, showing that trees may be left to a good size with the assurance that the income they are bringing in is steadily increasing.

Note the difference when the last table is reached, for trees on poorer land of slow growth. A tree 8 inches in diameter is shown to grow yearly .24 cubic foot. At 11 inches the growth is .36, half as much more. But here it has reached its limit. That seems to be about as much as the soil conditions will allow it to grow, so there it hangs. These facts show what a difference there will be in the policy maintained toward different tracts when timberlands come to handled to best advantage.

Most striking however is the actual difference in the producing power of trees on these 2 grades of spruce land. Trees on one produce on the average just about twice as much as on the other. Of course finer grading of the sites might have been made. Conditions run into one another. Some timber grows more slowly than anything here recorded.

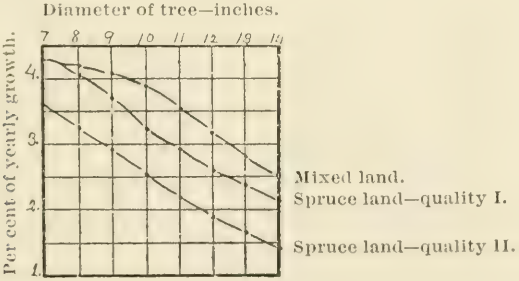
All these facts are clearest seen when they are graphically represented. Let us take for instance the growth in volume. Taking a sheet of paper ruled into squares we will put on the horizontal line at the bottom the numbers 7, 8, 9, 10, 11, 12, 13 and 14, the diameters of our classes of trees. In the same way on the vertical line at the left we will put at regular intervals the numbers .1, .2, .3, etc., representing the amount of yearly growth in parts of a cubic foot. Now in our tables for hard wood land 12 inch trees were shown to grow .7 of a cubic foot yearly. We will therefore mark a point where the line up from 12 and the line across from 7 intersect. In the same way, at 11 inches diameter trees in the same kind of land produce .64 of a cubic foot. On the line up from 11, therefore, we will mark another point, nearly half way up between the lines across from 6 and 7. In the same way the volume of the yearly growth at all sizes of the tree is plotted, when the points may for clearness' sake be connected by a curve. The rise in this curve then shows



at a glance gain in the yearly accretion. Rapid along to about 11 inches in diameter, its rise there is less rapid, but it still continues to rise, nevertheless, throughout its length as here drawn. Plotting the facts for the spruce land of first quality shows much the same thing. When, however, we come to the land of poor quality the relation of things is quite different. The curve falls in the first place much below that characteristic of the better soils. But further than that it is to be noted that the last of the line is horizontal. Growth then, as was seen in the tables, has ceased to increase and is holding its own.

One more fact about these curves remains to be pointed out. The curve for mixed land is seen to cross the other two, which means that while for trees 10 inches and upwards the volume growth is greatest on mixed land, for trees 7 inches and smaller it is greater on the spruce land. This is perhaps more apparent than true, and if true more interesting than valuable. But it does look reasonable. These trees stood in land that had been cut through, and in hard wood land far more would be left to shade the small trees than in pure or nearly pure spruce timber.

With what has gone before a diagram representing the percentage growth of the same stands and sizes of trees will perhaps be understood without explanation.



The larger use which is made of these figures in this work has been previously referred to and illustrated. By them has been estimated the growth upon particular tracts of land, and upon the whole extent of territory over which exploration has been carried.

Thus on No. IV, R. VII, a country of rocks and moss with slow-growing spruce upon it, we got the annual yield on the cut-over land by using a factor of 2 per cent on the amount of wood which was thought to be standing. 2 per cent it is seen stands in the table of growth for such land as the percentage for trees between 11 and 12 inches in diameter.

Again on the Moose river say a township covered with mixed growth has been closely cut for saw logs, and as a result of exploration it is determined that 300 or 400 cubic feet of small spruce are still standing on the land per acre. Looking into the table of growth for such land, 3 and one-half per cent will be found to be a fair percentage to apply to it to ascertain its annual increase. That was, in fact, just what we did in the case of Dennis. So with Brassua, a township of black growth on most of which the accretion is rather rapid. As a result of exploration it was judged that an average of about 400 cubic feet of spruce was standing on the land. To this we applied 3 per cent as a factor, getting thus a yearly growth of 12 cubic feet or 48 board feet per acre. With these results in hand and putting together all that had been learned about the drainage, we set the yearly growth of the Moose river basin at not less than 18 million feet. A similar computation can be made for a region of larger extent, the degree of its proximity to the truth depending on the accuracy of our knowledge of its topography, its stand of timber, and the history of its cut.

The following table, embracing the results of observation on about 50 spruce standing in high mountain land on the Kennebec, will be worth recording. Poor sites of whatever nature have a small growth, alike in a volume and percentage. Less thrifty trees than these might readily have been found.

Mountain Spruce, from Steep, Rocky Land with Little Soil—Mt. Bigelow and Hobbstown.

Two-thirds of trees from 2,000 to 2,500 feet above sea.

Diameter, inches.	Estimated volume cubic feet.	Growth Last 10 Years.		Yearly growth cubic feet.	Number trees involved.
		In diameter inches.	In % at Compound interest.		
7	4.3	.9	3.6	.15	8
8	6.7	.83	2.8	.19	3
9	8.6	94	2.8	.24	8
10	11.4	.54	1.4	.16	9
11	13.7	.65	1.55	.21	12
12	17.2	.8	1.9	.33	9

The observations behind the above tables were recorded with a view to general results. In order that they might thus serve, the observations had to be freed from the dangers attending selection. It was desired to find the actual production of the country rather than to determine any possible ideal. Therefore, when such notes were taken it was the usual practice to take all trees come to. In starting in, however, there was some variation in this practice, and throughout the work on the Kennebec I did allow myself some leeway. That is, very unthrifty trees were avoided, and an occasional very heavy crowned one as well. The results so understood, however, are thought to be representative. They cannot be much if any above the actual average of the country. They are doubtless less than by careful handling could be obtained.

When exploring on the Androscoggin I put myself under a stricter rule. When notes were taken only very seldom was a tree of the size desired passed by, in those few cases where a tree was evidently diseased or very badly crippled by suppression. The fact probably accounts for the difference in scale between the figures from the Kennebec and those from the Androscoggin. The accompanying table of growth for spruce on cut-over lands on the Androscoggin is based on observations on about 300 trees. The stands most often represented are mixed spruce and hard wood.

One other thing may account for the difference spoken of in part. The Androscoggin lands traversed were on the average some 400 feet higher than those explored on the Kennebec. If the difference is due to this fact, a striking relation is here found. That is, the region of the heaviest stands and the largest and finest trees has yet a slower growth in diameter, volume and per cent. I can only state this suggestion and hope for further light.

The subject of the representative character of these figures was discussed on page 124.

Diameter of trees breast high.	Volume cubic feet.	Growth During Last Ten Years.		Yearly growth —cubic feet.
		In diameter 4 feet from ground —inches.	In % at compound interest.	
7	5.5	.68	2.9	.15
8	8	.99	3.1	.25
9	11.5	.93	2.9	.33
10	15.5	.93	2.65	.41
11	20.	1.04	2.4	48
12	24.5	.98	2.15	.52
13	28.5	.92	1.9	.54

Course of values for volume, per cent and yearly growth in volume evened by drawing curves.

E—Waste of Lumber in Top and Stump.

A Kennebec paper mill company, owning a township which they intended to cut, wished for information as to the probable amount to be saved if instead of letting the work out to jobbers they cut it themselves. They were thinking of the loss at the top principally. They thought they could use the lumber in most trees down to a diameter of about 5 inches.

As a partial answer to their inquiry, the following table was got together. I took my notes of trees measured in the works of a representative Kennebec lumberman (notes such as were explained in section C of this appendix) and for each tree ascertained these three things—first the volume of the tree entire from the ground to the very top; second, the volume of the log cut; third, the volume that would have been obtained had the stem been taken up to a diameter of five inches. The individuul figures given in the accompanying table may be summed up as follows: The lumberman in this case actually took away 70 per cent. of the trees cut down. Had he cut them longer, up to where the trees were 5 inches in diameter, he would have got 26 per cent more wood. This is saying nothing about possible saving in the stump. Had the trees been sawed down at a uniform height of 15 inches from the ground, there would have been gained, as near as I can get at it, 1 3-4 cubic feet per tree more, adding 7 per cent. more to the actual cut. The saving in both directions amounts to an average of 8 cubic feet per tree in this moderate sized timber. In board measure that would be, if fairly scaled, somewhere about 40 feet per tree. Just a third in volume under the suppositions made, could have been added to the cut.

ECONOMY IN CUTTING.

Moosehead region. Maine scale rule. Cutting by a man who buys stumpage and sells his logs.

Breast diameter.	Volume in Cubic Feet of		
	Tree.	Log taken.	Stem to 5 in. diam.
15	30.5	20.7	27.5
15	33	21.3	30
13	30.7	24	27.5
11	22	16	19.5
15	45	30	41
15	35	24	31.3
16	50	30.7	44.8
19	65	48.3	57
13.5	40	31	37.3
13.5	37.2	29	33.2
13	29.3	22.5	26.2
12.5	26	18.4	22.7
11.2	24.5	17	22
12.5	33.7	21.6	30.4
11.3	23	16.5	21.4

The actual practice in this case is good practice for the Moosehead region. Stumps averaged about 2 feet in height, and choppers won't cut lower than that unless under strict rule and supervision. As for the top lumber, it can be said that if these logs had been cut longer they would not have brought so much unless the usual rules of scaling had been modified. Such logs would have been hard to sell, too, partly because lumber reaches the market usually in the other shape, partly because Kennebec manufactures have not got round to the idea that they can profitably use knotty top lumber. From this point of view comparsion will be interesting with the logs of a concern cutting on their own land to stock their own mill. This set of figures gives the diameter at which the logs were topped off and the percentage of the total contents of the trees saved, for each tree and for the whole. About 71 per cent of the total contents is here saved, a somewhat larger per cent in trees over 14 inches in diameter than in those below. I expected to find much more difference in the economy of the two cuts.

ECONOMY IN CUTTING.

Moosehead region. Maine scale rule. Cutting by owners of land for their own mills.

	TREES UP TO FOURTEEN INCHES DIAMETER.						TREES OVER FOURTEEN INCHES DIAMETER.				
	Breast diameter.	Volume of tree.	Volume of log cut.	Top diameter of log.	Per cent saved.		Breast diameter,	Volume of tree.	Volume of log cut.	Top diameter of log.	Per cent saved.
	12	25	18	8.5	72		15	39	27.5	9	71
	12	26	18	8.5	69		17	65	47	12	72
	12.5	27	17	9	63		14.5	40	29.5	10	74
	12	23.5	16	9	68		16	55	42.5	11	77
	13	29	23	8	79		15	43	30	10.5	70
	11	21	14.5	8	69						
	13	29	18.5	8.5	67						
Average..	......	....	....	......	69.8	Average..	....	......	......	.....	72

Next are given two sets of figures from the lumber of stumpage cutters on the Penobscot river. If anyone thinks the mention of locality irrelevant, he has only to compare these with the preceding figures. Our

ECONOMY IN CUTTING.

Penobscot river, Maine scale rule. Cutting done by a man who buys stumpage and sells his logs.

TREES UP TO 14 INCHNS DIAMETER.					TREES OVER 14 INCHES DIAMETER.				
Breast Diameter.	Volume of tree.	Volume of log cut.	Top diameter.	Per cent saved.	Breast diameter.	Volume cubic feet.	Volume of log cut.	Top diameter.	Per cent saved.
12	25	16.6	9.5	64	27	162	121	20	73
12	27	14	9.5	52	16	48	29	12.5	60
11	23	14	8	61	15	44	25	11.5	57
13	34	22	10.5	65	18.5	69	44	13.5	64
13.5	35	17.5	11	50	21	94	68	15	73
12	27	15.5	8.5	57	16	52	30	12	58
14	37	20	10	54	16.5	51	30	12	59
11.5	26	16	9	61	17	46	31	11.5	67
10	18	9.5	8	53	15	36	22	11	61
Average.........................				57.3	Average				66.4

Kennebec representatives saved on the average 70 per cent of the total wood contents of their trees. Here the average is rather less than 60 per cent. The last lot of figures is especially noteworthy. These were for large trees in virgin timber, trees that should cut with small waste, yet there was taken out of the woods only 57 per cent of the lumber cut down. Large logs were frequently cut less than 30 feet long, no top logs being taken. Trees as large as 11 inches in diameter breast high, cut in the roads, were left on the ground to rot. And this was by no means on very distant or difficult land.

CIRCUMSTANCES & LOCALITY SAME AS LAST.

Breast diameter.	Volume of tree.	Volume of log cut.	Top diameter.	Per cent saved.
19	72	45	15	63
18	62	33	14	53
14.5	37	22	11	59
22.5	111	57	17	51
16	43	25	11.5	58
14.5	38	22	11	58
36	149	79	19	53
25.5	151	83	20.5	55
14.5	43	24	12	56
19	63	35	14	56
21	90	59	15.5	66
14	37	21	11	57
15	45	30	12	67
Average..............				56.9

When I started in to make these tabulations it was with a view to demonstrating the waste caused by the use of a top-end scale rule. There is too much of it here, however, to be accounted for in that way. Such cutting as this is an heirloom from ancient times. Men were brought up to cut that way, they never have been elsewhere to get any new ideas, they keep on consequently in the same old fashion. Such logs of course sell well. They are clear and fine. Many mill men think they cant use top lumber, and their hand-down ideas aid those of the lumberman in maintaining the fashion.

It may have been the case, too, that these lumbermen were so situated that they had to cut in this wasteful way. Sometimes stumpage is held so high that a man can take only the cream of the timber, such as will scale best and bring the very topmost piece. I am reminded in this connection of a conversation between an acquaintance of mine who is a thorough and progressive woodsman, and a prominent land-owner of the Kennebec. The owner was speaking of the great returns derived from a certain town. For some of the lumber he said he had collected $4 a thousand stumpage.

The woodsman had recently explored the tract in question and answered at once that in his judgment the owner didn't get $1.50. That was a startling statement, but it may readily have been perfectly true. When men pay $4 stumpage, they take only $4 lumber. They take the largest trees only, and only the clear parts of them. They slash through the country with their roads and suffer nothing to stand that is in their way. And in the situation they are put, they can't do otherwise. Cut in that way it is very easy to understand that not half the timber killed by the lumbermen may be taken from the land. This says nothing of the windfall which so often enters on their departure.

Economy in Cutting.

Lumber cut on west slope of Mt. Washington in New Hampshire.
Blodgett scale rule (calipers).

	TREES UP TO FOURTEEN INCHES DIAMETER.						TREES OVER FOURTEEN INCHES DIAMETER.				
	Breast diameter.	Volume—cubit feet.	Volume of log cut.	Top diameter.	Per cent saved.		Breast diameter.	Volume—cubic feet.	Volume of log cut.	Top diameter.	Per cent saved.
	13	32	28	6	85		18	55	47	6.5	85
	12.5	28	24	7	86		17.5	52	45	6	87
	11	20	15	7	75		14.5	35	30	7	86
	12	19	15	7.5	79		16	47	42.5	7.5	90
	11.5	21	17	7	81		14.5	31	27	7	87
	13.5	35	31	7	89		17.5	45	38	6	84
	14	36	31	7	86		20	58	49.5	8.5	85
	14	33	29	7	88		20	64	55	8.5	86
	10	14.5	12	6	83		17	47	42	8	89
Average..	....	....	......	.....	84.7	Average..	......	.....	......	......	86.7

Finally, as showing what may be done if men only think so, and if through their business organization and scaling methods they put no obstacle in the way, these last figures are presented, of timber cut on the west side of Mt. Washington in New Hampshire. In this case eighty-six per cent of the trees cut was actually taken from the ground. This high degree of economy I believe is reached in a good deal of present Androscoggin cutting.

We have now opportunity to make an interesting comparison. All these figures were taken from lots of logs as they ran. Each group so far as I can judge is approximately representative of much of the cutting in its region. Leaving out of account now the various causes which go to cause the difference, putting our figures for the different rivers together as representing the degree of economy attained, we have the following striking result:

Of trees cut for logs 60 per cent. is utilized on the Penobscot.
" " " 70 " " " " Kennebec.
" " " 86 " " " " Androscoggin.

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